



### ***AfricaMaVal***

#### *Coordination and Support Action (CSA)*

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#### **Fact sheets on project evaluation (strategic, economic, ESG, infrastructure)**

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Summary

The project fact sheets shall provide an evaluation of selected ECRM industrial mining projects in the upstream mineral supply chain (exploration, mining, processing, refining) with regards to their strategic, economic, ESG and infrastructure parameters. Where applicable, the project evaluation shall consider both local opportunities based on national developments as well as the international (EU) perspective as far as responsible mineral sourcing and investment is concerned. The infrastructure evaluation considers both logistics and energy requirements. A total of about 100 project fact sheets shall be generated.

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Horizon Europe Framework Programme (HORIZON)

## **D7.1 – Factsheets on African Mining Project Evaluation (Strategic, Economic, ESG, Infrastructure)**

### **WP7 – Tasks 7.1, 7.2, 7.3**

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## Abbreviations and Acronyms

| Acronym | Description                                                       |
|---------|-------------------------------------------------------------------|
| ABM     | Alphamin Bisie Mining SA                                          |
| AM      | Ambatovy Minerals                                                 |
| AfDB    | African Development Bank                                          |
| AIM     | Alternative Investment Market                                     |
| AMD     | Acid Mine Drainage                                                |
| ASM     | Artisanal and Small-Scale Mining                                  |
| ASX     | Australian Securities Exchange                                    |
| BCL     | Bamangwato Concessions Ltd.                                       |
| BESS    | Battery energy storage system                                     |
| BIC     | Bushveld Igneous Complex                                          |
| BFS     | Bankable Feasibility Study                                        |
| BGR     | Federal Institute for Geosciences and Natural Resources (Germany) |
| BRGM    | Bureau de Recherches Géologiques et Minières (France)             |
| CAHRA   | Conflict-affected and high-risk Areas                             |
| CAPEX   | Capital Expenditures                                              |
| CBG     | Compagnie des Bauxites de Guinée                                  |
| CMA     | Critical Minerals Association                                     |
| CSE     | Canadian Stock Exchange                                           |
| CSR     | Corporate Social Responsibility                                   |

|        |                                                     |
|--------|-----------------------------------------------------|
| DFS    | Definitive feasibility study                        |
| DMS    | Dense media separation                              |
| DPM    | Dundee Precious Metals Inc.                         |
| DRC    | Democratic Republic of the Congo                    |
| DSO    | Direct shipping ore                                 |
| EAC    | East African Community                              |
| ECRM   | Extended critical raw materials                     |
| EIA    | Environmental impact assessment                     |
| EITI   | Extractive Industries Transparency Initiative       |
| EMP    | Environmental management plan                       |
| ERMA   | European Raw Materials Alliance                     |
| ESG    | Environment, social and governance                  |
| ESHIA  | Environmental, social, and health impact assessment |
| ESIA   | Environmental and social impact assessment          |
| ESRS   | European Sustainability Reporting Standards         |
| EU     | European Union                                      |
| FOB    | Free-on-board (Incoterms)                           |
| FSX    | Frankfurt Stock Exchange                            |
| GHG    | Greenhouse gas                                      |
| GRI    | Global Reporting Initiative                         |
| HMS    | Heavy mineral sands                                 |
| HP EMM | High-purity electrolytic manganese metal            |

|       |                                                    |
|-------|----------------------------------------------------|
| HPAL  | High-pressure acid leach                           |
| HPMSM | High-purity manganese sulphate monohydrate         |
| ICGLR | International Conference on the Great Lakes Region |
| ICMM  | International Council on Mining and Metals         |
| IFC   | International Finance Corporation                  |
| ILO   | International Labour Organization                  |
| IRENA | International Renewable Energy Agency              |
| IRMA  | Initiative for Responsible Mining Assurance        |
| ISO   | International Organization for Standardization     |
| IUCN  | International Union for Conservation of Nature     |
| JORC  | Joint Ore Reserves Committee                       |
| KBA   | Key biodiversity area                              |
| KCM   | Konkola Copper Mines                               |
| LCA   | Life cycle Assessment                              |
| LOM   | Life-of-Mine                                       |
| MCM   | Mopani Copper Mines                                |
| MMC   | Manganese Metal Company                            |
| MoU   | Memorandum of Understanding                        |
| MREC  | Mixed rare earth carbonate                         |
| MREDS | Mixed rare earth double sulphate                   |
| MSP   | Mixed sulphide product                             |
| NMC   | Nickel-manganese-cobalt                            |
| NPV   | Net present value                                  |

|        |                                                        |
|--------|--------------------------------------------------------|
| OECD   | Organisation for Economic Co-operation and Development |
| OHS    | Occupational health and safety                         |
| OHSAS  | Occupational health and safety assessment series       |
| OPEC   | Organization of the Petroleum Exporting Countries      |
| OPEX   | Operational expenditures                               |
| (P)CAM | (Precursor) Cathode active material                    |
| PEA    | Preliminary economic assessment                        |
| PFS    | Pre-feasibility study                                  |
| PGE    | Platinum group elements                                |
| PNR    | Premium Nickel Resources Ltd.                          |
| QCA    | Quoted Companies Alliance                              |
| REE    | Rare earth elements                                    |
| REIA   | Rare Earths Industry Association                       |
| REO    | Rare earth oxide                                       |
| ROM    | Run of mine                                            |
| RRAP   | Relocation and resettlement action plan                |
| SASB   | Sustainability Accounting Standards Board              |
| SC6    | Shipping class 6% (lithium concentrate)                |
| SEZ    | Special economic zone                                  |
| SLP    | Social Labour Plan                                     |
| SNC    | Sama Nickel Corp.                                      |
| TCFD   | Task Force on Climate-Related Financial Disclosures    |
| TEU    | Twenty-foot equivalent unit                            |

|         |                                                                  |
|---------|------------------------------------------------------------------|
| TGC     | Total graphitic carbon                                           |
| TNFD    | Taskforce on Nature-related Financial Disclosures                |
| TREO    | Total rare earth oxide                                           |
| TRIFR   | Total recordable injury frequency rate                           |
| TSF     | Tailings storage facility                                        |
| TSX     | Toronto Stock Exchange                                           |
| TSXV    | TSX Venture Exchange                                             |
| UAE     | United Arab Emirates                                             |
| UK      | United Kingdom                                                   |
| UNECA   | United Nations Economic Commission for Africa                    |
| UNESCO  | United Nations Educational, Scientific and Cultural Organization |
| USA     | United States of America                                         |
| USGS    | United States Geological Survey                                  |
| VAT     | Value-added tax                                                  |
| WCP     | Wet concentrator plant                                           |
| WP      | Work package                                                     |
| ZCCM-IH | Zambia Consolidated Copper Mines – International Holding         |
| ZIM     | Zimbabwe Lithium Company                                         |
| ZNC     | Zeb Nickel Corporation                                           |



## Executive Summary

This report presents 80 factsheets of exploration, mining, refining and infrastructure projects or regional clusters related to critical and strategic raw materials all across Africa. The purpose of these factsheets is to act as teasers for initiating targeted discussions on mineral value chain development, partnerships and supply security among project developers in Africa and the European downstream industry, financial sector and investment community. The target group further includes policy makers and public bodies, notably including the European Commission. The factsheets represent an independent, introductory assessment of project economics (including economic geology), ESG (environmental, social and governance) factors, and infrastructure, performed by BGR (mining and ore deposit-related content) and DMT / DMT Kai Batla (infrastructure-related content), as a contribution to work package 7 of the EU-funded AfricaMaVal coordination and support action. The report illustrates mining projects and regional infrastructure clusters meeting certain selection criteria. The selection is deliberately diversified in terms of geography, commodity, project maturity and value chain position. The report does not claim complete coverage of critical raw material projects in Africa – it is merely intended as a starting point to stimulate follow-up discussions by the stakeholder groups identified above.

While the presented projects were selected against certain criteria, the authors and their organisations do not generally endorse the presented projects as universal investment opportunities. Rather, it is up to interested private and public sector stakeholders to classify a given project as a potential investment opportunity, based on their own strategic priorities, compliance expectations, risk appetite and further due diligence. Potential investors and other stakeholders are therefore advised to carefully evaluate any presented project of interest against their own standards, but may use the information presented in this report as a starting point for such evaluations. Presented project input data were largely based on public information provided by project developers, mostly through formal project development studies or press releases. Although it may be assumed that these data sources often comply with certain quality standards, it is important to note that the accuracy of the information provided therein was not independently verified for this report. The data presented in a given factsheet reflect the information available to the authors at the date indicated at the top of each factsheet. Further project development updates beyond this date are not reflected in the present report.

## Keywords

Critical raw materials, strategic raw materials, Africa, exploration, mining, refining, project economics, ore deposits, ESG, infrastructure, investment, supply security, value chains

# 1 Introduction

The European Union (EU)-funded project “Building EU-Africa Raw Material Value Chain Partnerships” (AfricaMaVal) contributes to identifying potential investment opportunities and supporting value chain partnerships between African and European countries. Running from 2022-2025, the AfricaMaVal project is embedded in a range of EU policy initiatives in relation to strengthening European supply of critical and strategic raw materials (termed ‘extended critical raw materials’, ECRM, within the AfricaMaVal project). These EU initiatives include, in particular, the recently published Critical Raw Materials Act and bilateral strategic raw material partnerships on the background of achieving the ‘twin transition’ targets of the Green Deal and the European digital transition.

The AfricaMaVal project comprises 10 technical and administrative work packages. The present report is associated with work package 7, ‘Responsible investment opportunities.’ It represents a joint deliverable by the Federal Institute for Geosciences and Natural Resources (BGR), DMT GmbH & Co. KG, and DMT Kai Batla. The report integrates findings associated with AfricaMaVal tasks 7.1 (Preliminary project and country screening), 7.2 (Strategic, economic and ESG evaluation for industrial investment projects), and 7.3 (Infrastructure evaluation for industrial investment projects). For further details on task responsibilities, the reader is referred to chapter 9.3 of this report. Within AfricaMaVal work package 7, the follow-up task 7.6 “Development of responsible ECRM investment opportunities and recommendations” (2024-2025) aims to build on the present report, while also providing new analysis and additionally considering relevant findings from AfricaMaVal’s consortium of 18 African and European partners.

The aim of this report is to generate attention on ECRM projects of interest in Africa among the European downstream and financial industries, service providers and policy makers. Stimulating discussions on project-related financing, investment and offtake agreements is meant to support project development and associated value chain partnerships between Africa and Europe. To this end, the report illustrates relevant economic, environmental, social and governance (ESG), and infrastructure features for projects of interest which were pre-selected against certain criteria defined in the next chapter. Thus presented information shall act as a teaser to encourage more detailed project evaluations by interested public or private sector stakeholders.

The scope of the report refers to a broadly diversified range of exploration, mining and refining projects (and, in some cases, further value addition) of different development status (maturity), as well as regional infrastructure clusters. The report presents project- or cluster-specific findings in individual subchapters whose use as stand-alone project factsheets (outside of this report) is encouraged by the authors.

The presentation of a project factsheet in this report does not imply that the authors and their organisations directly recommend investing in that specific project. Rather, the factsheets are meant to provide an introductory overview, draw attention to relevant questions, and encourage interested parties to perform their own due diligence, in line with their organisation's strategy, corporate values, compliance standards and internal processes. As such, this report may be regarded as a starting point for follow-up discussions among the stakeholder groups identified above.

## 2 Project selection and evaluation methods

### 2.1 Project selection

When identifying projects of interest for this report as part of AfricaMaVal task 7.1, the BGR aimed for an overall balanced and well-diversified project distribution in terms of ECRM commodity coverage, geography (considering each African country's general ECRM endowment), project development status (from early-stage exploration projects to expanding mining projects already in active production), and value chain position (exploration, mining, refining/further value addition, and re-mining/re-processing of tailings). The project diversification across these categories shall contribute to broad applicability of potential investment and engagement opportunities, increased supply chain resilience, and flexibility in terms availability of ECRM supply through time. Supply diversification is an important measure to increase supply security both at the level of individual downstream companies and for the EU as a whole.

Against this general background, projects presented as factsheets in this report were identified by BGR based on (1) a review of relevant projects stored in the S&P Global (2024) database; (2) in-house information available at the BGR, based on its technical cooperation activities in Africa as well as industry contacts; (3) outreach to AfricaMaVal consortium partners, particularly in the context of AfricaMaVal case studies implemented in 10 African countries. Relevant feedback was received from the French Geological Survey (BRGM), from DMT GmbH & Co. KG/DMT Kai Batla, and from the Portuguese Geological Survey (LNEG). Additional feedback on West Africa was provided by German Development Cooperation (GIZ), a member of the AfricaMaVal advisory board. Based on these different inputs and the general considerations listed in the previous paragraph, BGR identified 141 exploration, mining and refining candidate projects in total.

These ECRM candidate projects were then tested against the following screening criteria, where the first three criteria received most research attention:

- A sufficient level of information is available to allow developing a meaningful factsheet – this excludes very early-stage projects without at least a maiden resource estimate while also excluding projects where operators/owners do not publish or otherwise share relevant reports;
- The project is associated with credible ECRM mineral resources or a generally credible business concept;
- Part of the project's anticipated ECRM output is potentially available to the EU industry – this requires the project not being fully controlled by third party operators from certain jurisdictions (e.g., from China or Russia) or having large parts of its production capacity committed to offtake agreements outside of Europe;

- The project developer seeks attracting financing/investment (for instance for mine construction, modernisation or expansion) or ECRM offtake partners;
- The project is not located in any sensitive protected area (e.g., IUCN categories I-IV).

From the 141 identified candidate projects, BGR, in consultation with the above AfricaMaVal partners, selected 59 projects that, in all likelihood, fulfilled the above requirements at the time of research. An index of all projects and their respective host country and primary commodity is shown in chapters 9.1 and 9.2, respectively.

Importantly, relevant changes (e.g., in ownership) after completion of work on a given factsheet are not reflected in this report. Given the business dynamics of the ECRM sector, it is likely (and was indeed observed) that several projects included in this report no longer fulfil all of the above screening criteria at the time of report publication, although they did at the time when the specific factsheet was developed. For this reason, a date is shown at the beginning (top right) of each factsheet, showing the latest update of the information used for this particular factsheet. Any additional, more recent information, for example from new development studies that have been published since then, was not considered after completion of the work on a given factsheet. This also impacts on the information further described in chapter 2.2 below.

## 2.2 Project evaluation

Factsheets on exploration, mining and refining/value addition represent high-level overviews, typically comprising sections on economic geology and mining economics as well as on ESG parameters of a given project. These sections were compiled as part of AfricaMaVal task 7.2. Selected factsheets additionally feature a section on project infrastructure parameters. A total of 21 factsheets are exclusively dedicated to regional infrastructure clusters, as described in chapter 2.3. This infrastructure-related work formed part of AfricaMaVal task 7.3.

The factsheets are largely based on publicly available information, usually published by project developers, for instance in (pre-)feasibility studies or annual reports. These information were deemed to be sufficiently accurate for an introductory project overview, though not verified in further detail as would be the case during audits or detailed due diligence assessments.

Outreach efforts to project developers were made directly through the BGR or, in some cases, through AfricaMaVal country case study leaders (work package 9). Based on these outreach efforts, a number of project developers reviewed draft factsheets or engaged in follow up discussions to clarify open questions. The field “Contact to operator” on each factsheet indicates whether or not the project developer engaged in such activities. With the exception of few projects in Namibia, the DRC and Rwanda, on-site project visits were not conducted to supplement fact finding. In one case (Tanzania), a factsheet was developed as a conceptual project idea, building on anecdotal information and general background expertise of the author.

The factsheets do not represent investment advice by the authors and their organisations, and these parties are not liable for any inaccuracies potentially included. As such, the information provided in this report does not constitute a confirmation by the authors of the technical viability and economic feasibility of a given project. The assessment comments provided in individual project factsheets may provide comments impacting on these factors, such as cut-off grades or price assumptions used in project development studies, but interested potential investors are advised to carefully review and verify these data and assumptions.

The factsheets, in their function as teasers, may allow interested European parties to engage in targeted follow-up discussions with project developers in Africa on their own initiative, which should at some point include their own detailed due diligence assessments. It is up to potential investors to classify any of the presented projects as an actual investment opportunity in case a given project meets their standards based on their own due diligence.

The factsheets do not cover specific projects related to the artisanal and small-scale mining (ASM) sector because information availability for specific ASM projects is usually insufficient. Therefore, ASM sector ECRM production trends and the framework for investment opportunities are described in other AfricaMaVal tasks (see deliverables D1.4 and D7.2), where they are presented at national level, rather than at the individual project level. The factsheets in this report do however include a conceptual factsheet on a copper leaching plant processing feed from ASM operations, and they further include two factsheets that refer to semi-mechanised or semi-industrial small-scale mining operations.

Factsheets are divided in the following subsections: General information; economic assessment; ESG assessment; and (for a selection of factsheets) infrastructure assessment. At the end, each factsheet includes a project-specific bibliography, which shows the key documents used for compiling the factsheet.

The content used for each factsheet subsection is as follows.

|                          |                                                                                                                                                                                                                                                                                                                                     |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b> | <ul style="list-style-type: none"> <li>Refers to the most economically valuable metal/material extracted from the ground by mining operations as a component of the ore, or recovered (from concentrates or other intermediate products) by smelting or refining processes.</li> </ul>                                              |
| <b>Other commodities</b> | <ul style="list-style-type: none"> <li>Refers to economic or potentially economic by-products or co-products, which may be metals/materials extracted from the ground by mining operations as a component of the ore, or recovered (from concentrates or other intermediate products) by smelting or refining processes.</li> </ul> |

**Please note: Selected projects may contain ECRM either as primary commodity or as other commodities.**

|                               |                                                                                                                                                                                                                    |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Location</b>               | <ul style="list-style-type: none"> <li>Includes names of the region/province and country, latitude, longitude and elevation.</li> </ul>                                                                            |
| <b>License type</b>           | <ul style="list-style-type: none"> <li>Includes, depending on available information, all types of licenses (e.g., exploration, mining), license numbers and the area covered by the individual license.</li> </ul> |
| <b>License owner/operator</b> | <ul style="list-style-type: none"> <li>Includes all license owners and operators.</li> </ul>                                                                                                                       |
| <b>Contact</b>                | <ul style="list-style-type: none"> <li>Includes physical address, email addresses and website information.</li> </ul>                                                                                              |

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Project status</b>              | <ul style="list-style-type: none"> <li>Includes an arrow graphic for quick and rough orientation along the project development path displaying (i) Scoping &amp; Pre-feasibility, (ii) Feasibility, (iii) Construction and (iv) Mining, Smelting, Refining, Expansion. It further includes a more project-related brief status description.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Possible production by 2030</b> | <ul style="list-style-type: none"> <li>While the factsheets deliberately do not show detailed project-specific timelines for each development phase (since these are frequently subject to change), it is important to generally understand when a given project can be expected to deliver critical raw materials to the market. Therefore, this category assigns a qualitative probability to the project entering production before or after the reference year 2030. The latter year was selected due to its relevance as a benchmark for the EU's Critical Raw Materials Act. The assessment is based on corporate information accessed via S&amp;P Global (2024). Where these information were not available, the assessment reflects BGR's own judgement, based on project complexity and implementation progress.</li> </ul> |
| <b>Project location map</b>        | <ul style="list-style-type: none"> <li>Includes the project location, claims linked to the properties and further claims of the project owner as well as all transport opportunities related to the individual project, such as major and minor roads, railway lines and international ports.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

Table 1. Factsheet methods – general project background

|                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>General project background</b>                                    | <ul style="list-style-type: none"> <li>Includes a short description about the project, depending on available information, highly depending on the project (e.g., history, geology, status, commodities, capacity, investment required).</li> </ul>                                                                                                                                                                                                                                                                                                                                       |
| <b>Project description (Key figures from technical reports):</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Ore deposit type</b>                                              | <ul style="list-style-type: none"> <li>Refers to, if necessary, the ore deposit formation, geology, type of mineralisation, and host rock of the mineralisation, etc.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Current Reserves</b>                                              | <ul style="list-style-type: none"> <li>Include the total amount of probable and proven reserves according to international standards (if not stated otherwise) as well as the grades of ECRM and other economically relevant commodities.</li> </ul>                                                                                                                                                                                                                                                                                                                                      |
| <b>Resources</b>                                                     | <ul style="list-style-type: none"> <li>Include the total amount of inferred, indicated and measured resources, exclusive of reserves, according to the international standards (if not stated otherwise) as well as the grades of ECRMs and other economically relevant commodities.</li> </ul>                                                                                                                                                                                                                                                                                           |
| <b>Shares of global commodity resources, reserves and production</b> | <ul style="list-style-type: none"> <li>Global resources, reserves and production figures used as global reference for the commodity context either refer to USGS (2023) or to Drobe (2020).</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Waste to ore ratio</b>                                            | <ul style="list-style-type: none"> <li>Describes the amount of waste material (overburden or gangue, that is, non-valuable rock) that must be removed to extract a certain amount of valuable ore.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Annual production</b>                                             | <ul style="list-style-type: none"> <li>Depending on information available, the annual production describes the average amount of ore mined, concentrate produced, metal contained or high-purity product obtained in a year (over the entire life of mine; concentrator, smelter, refinery).</li> </ul>                                                                                                                                                                                                                                                                                   |
| <b>Life of mine</b>                                                  | <ul style="list-style-type: none"> <li>Refers to the estimated period of time over which a mining operation is expected to be economically viable and productive based on the currently defined reserves and resources.</li> </ul>                                                                                                                                                                                                                                                                                                                                                        |
| <b>Investment required</b>                                           | <ul style="list-style-type: none"> <li>Refers to published capital expenditure or rough estimates (for conceptual projects without specific information) and its intended purpose. Additionally lists secured project financing where public information was found. Note that capital expenditure to bring a mine into production often increases through time compared to early estimates due to delays, inflation and other factors. Also note that 'investment' is used here as a summary term that may refer to all types of funding, such as financing by debt or equity.</li> </ul> |
| <b>Net present value</b>                                             | <ul style="list-style-type: none"> <li>Is a financial metric used to assess the profitability and value of an investment or project. It calculates the present value as a sum of the expected discounted cash flows (including commodity price assumptions) over the life of mine.</li> </ul>                                                                                                                                                                                                                                                                                             |

|                                 |                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Recovery</b>                 | <ul style="list-style-type: none"> <li>Refers to the percentage of valuable minerals or metals that can be successfully extracted from the ore during the processing or beneficiation stage. It represents the efficiency of the extraction process and is a critical factor in determining the economic viability of a mining operation.</li> </ul>             |
| <b>Value addition potential</b> | <ul style="list-style-type: none"> <li>Refers to the ability to increase the value of extracted minerals or materials beyond their raw form. This can be achieved through several means, including further processing and refining, product diversification, innovation and technology, downstream integration or market development and branding.</li> </ul>    |
| <b>Mining and processing</b>    | <ul style="list-style-type: none"> <li>Includes a general description of the planned mining and processing methods. If available, this paragraph refers to expected/current operational (OPEX) and capital (CAPEX) expenditures as well as expected revenues.</li> </ul>                                                                                         |
| <b>BGR assessment</b>           | <ul style="list-style-type: none"> <li>Depending on the information available, a general economic evaluation based on in-house subject matter expertise, comments on price adequacy, risk scenarios that may apply to the project, potential of the region, low or high cost producers, quality of the product sold as well as on the infrastructure.</li> </ul> |

**Table 2. Factsheet methods – economic assessment**

The ESG categories included in the factsheet were inspired by the IFC performance standards on environmental and social sustainability while selected criteria related to current due diligence requirements were also included. The resulting factsheet categories were consulted and adapted during a workshop with AfricaMaVal partners and public stakeholders in February 2023.

Information was gathered from public and, occasionally, internal technical reports, sustainability reports (often formal project development studies), company press releases etc. The accuracy of the information included in these data sources was not independently verified by the authors, though they are expected to comply with certain quality standards in case they were issued by publicly listed companies that are required to abide by the regulations of their respective stock exchange. Additionally, national / regional indicators are used for certain categories (e.g. Water Stress Index, Labour Rights Index – Links to the source are included in the following table). The extent and quality of available information differs between individual projects, e.g., depending on the development status.

Further assessment is based on expert judgement for each ESG category. The objective of this ESG assessment is not to provide an in-depth analysis of all investment-relevant aspects, but to provide an introductory overview and highlight ESG issues that might require particular attention.



Issues which, in the opinion of the authors, might pose a potentially high ESG risk or require special attention are marked by the exclamation mark symbol next to a given category, as shown next to this text.



| ESG category                                                       | Assessment criteria                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                             |
| Environmental management                                           | General management information, certification (e.g., ISO 14001), track record of incidents.                                                                                                                                                                                                                                                                                                                 |
| Efficient use of energy, renewable energy, GHG emissions reporting | Company information on scope 1 and scope 2 emissions, otherwise relate to commercial emission data, where available; energy demand information on grid and national energy mix; emission targets, reporting standards and target setting, technology applied.<br><a href="#">IEA – National Energy Mix</a> <b>Note:</b> IEA energy mix only if no project specific information available.                   |
| Water management and consumption                                   | Regional context (water scarcity, aqueduct water risk atlas, other high demand sectors), public reports on water-related conflicts, other water uses; company information on water demand and management, recycling, efficiency.<br><a href="#">Aqueduct Water Risk Atlas – Water Stress</a>                                                                                                                |
| Pollution prevention                                               | Acid mine drainage (AMD) potential from geology, chemical and hazardous substances used in processing, other geological factors (e.g., naturally radioactive material), technology applied.<br><b>Note:</b> Potential pollution risks under this category are of a general nature. Topic-specific risks as well as mitigation measures are addressed in the additional categories below (air quality etc.). |
| Air quality                                                        | Expected emissions due to processes and size of operation, technology, relevance for affected communities, management measures.                                                                                                                                                                                                                                                                             |
| Tailings management                                                | Risk factors (e.g. seismic activity), tailings management and standards, volume of tailings<br><b>Note:</b> This category only addresses tailings storage facilities. Management of other mining wastes are addressed under “Waste management”.                                                                                                                                                             |
| Waste management                                                   | Waste management policy and goals (zero waste), implementation of waste hierarchy approach; also including waste rock.                                                                                                                                                                                                                                                                                      |
| Hazardous materials management                                     | Risks related to chemicals of processing technology; company management measures.                                                                                                                                                                                                                                                                                                                           |
| Noise and vibration                                                | Related to technology, relevance for affected communities, company management measures.                                                                                                                                                                                                                                                                                                                     |
| Protected areas and biodiversity                                   | Location related to key biodiversity areas, protected areas (IUCN category if available, national classification), information on local biodiversity, company measures.<br><a href="#">Key Biodiversity Areas – KBA Map</a> ; <a href="#">Protected Planet – Protected Areas Map</a>                                                                                                                        |
| Mine closure                                                       | Closure obligations, evidence of planning and financial surety or assurance                                                                                                                                                                                                                                                                                                                                 |
| <b>Social and socio-economic issues</b>                            |                                                                                                                                                                                                                                                                                                                                                                                                             |
| Community health, safety and security                              | Expected impacts on local communities, related to emissions, infrastructure, impact on ecosystem services, security forces, emergency preparedness and response, local population affected.<br><a href="#">European Commission – Global Human Settlement Layer</a> to determine the density and distance to settlements.                                                                                    |
| Dialogue and engagement with communities and stakeholders          | Evidence of structured dialogue with local communities; information on conflict with communities.                                                                                                                                                                                                                                                                                                           |
| Land acquisition and involuntary resettlement                      | Information on settlements and cultural heritage sites in project area; grievances raised; resettlement actions.<br><a href="#">UNESCO – World Heritage Interactive Map</a>                                                                                                                                                                                                                                 |
| Occupational health & safety management                            | Evidence of adequate operational health and safety (OHS) policies and management; ISO 45001 certification, etc.                                                                                                                                                                                                                                                                                             |
| Workers' rights                                                    | Working conditions, terms of employment, living wage, collective bargaining, child/forced labour, retrenchment, grievance mechanism; non-employee workers, employees and contract workers, ASM production; ILO convention in country, national regulation; information on wages,                                                                                                                            |

| ESG category                                       | Assessment criteria                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                    | <p>minimum wage or verified living wage standards; company track record of conflicts/strikes; relevant company policies.</p> <p><a href="#">WageIndicator - Labour Rights Index 2022</a></p> <p><u>Note:</u> The Labour Rights Index provides an overview on the general national situation; project / company specific information when there is indication (e.g. company reports, news reports) for comparably better or worse performance.</p> |
| <b>Gender and diversity</b>                        | Policies for non-discrimination; equal opportunities for women; evidence of practice.                                                                                                                                                                                                                                                                                                                                                             |
| <b>Local value added and community development</b> | Local and national workforce; local procurement; training and education, Corporate Social Responsibility (CSR) measures, size of project, (qualitative) estimation of local value added from project design, comparable projects; taxes, royalties, fees paid to governments (e.g., as per EITI data).                                                                                                                                            |
| <b>Governance</b>                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Legal compliance</b>                            | Compliance with applicable laws, relevant licenses for project development / operation available, evidence (e.g. company reports, news reports) of any non-compliance as applicable.                                                                                                                                                                                                                                                              |
| <b>Management practices</b>                        | Information on ESG policies and management; risk assessment and planning, environmental and social management systems, emergency crisis and management, financial accounts, relevant certifications.                                                                                                                                                                                                                                              |
| <b>Transparency and reporting</b>                  | Sustainability reporting, reporting standards (e.g., GRI), financial reporting, stock exchange listing; transparency of ownership.                                                                                                                                                                                                                                                                                                                |
| <b>Business ethics</b>                             | <p>Supply chain due diligence policies and evidence; location in Conflict-affected and High-risk Areas (CAHRA); country corruption index; company policies; track record of incidents.</p> <p><a href="#">European Union - List of conflict-affected and high-risk areas (CAHRAs)</a></p> <p><a href="#">Transparency International – Corruption Perception Index 2023</a></p>                                                                    |

**Table 3. Factsheet methods – ESG assessment**

The infrastructure categories included in the factsheet were developed based on the outcomes of “WP 7 Infrastructure Roundtable” discussions organised by BGR during Mining Indaba, 2023. These categories were then refined and finalised as the project matured. Similar to the ESG assessment, the objective of the infrastructure assessment is not to provide an in-depth analysis of the investment costs, but to provide an introductory overview of the current state of infrastructure in the project area. Consequently, gaps in infrastructure developments are identified, highlighting areas where investments will be beneficial for the success of each project. The individual infrastructure analysis is therefore differentiated into the following two segments:

(1) Specific investment needs identified on the basis of the infrastructure assessment:

- Road infrastructure
- Railway enhancements
- Renewable energy ventures
- Water supply
- Port storage facilities

## (2) General infrastructure assessment sheet:

| Infrastructure category | Assessment criteria                                                                                                                                                           |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Site specific</b>    | Includes a short description about project condition and access.                                                                                                              |
| <b>Transport</b>        | Describes road access to project site and its conditions regarding import and export of products and resources to potential destination targets, e.g., airports, ports, hubs. |
| <b>Airport</b>          | Describes nearby airport locations and its conditions in order to evaluate its capacity for import and export of products and resources.                                      |
| <b>Rail Access</b>      | Describes rail access to project site and its conditions regarding import and export of products and resources to potential destination targets, e.g., airports, ports, hubs. |
| <b>Port</b>             | Describes nearby port locations and its conditions in order to evaluate its capacity for import and export of products and resources.                                         |
| <b>Energy</b>           | Describes the energy supply and consumption of the project.                                                                                                                   |
| <b>GHG Emission</b>     | Describes GHG emissions of project's processes and visions and measures to reduce GHG emission.                                                                               |
| <b>Water</b>            | Describes water supply for project's processes and plans for improving water management.                                                                                      |

**Table 4. Factsheet methods – Infrastructure assessment**

Information was gathered from publicly available technical reports, sustainability reports, company websites, and regional infrastructure projects. Therefore, the extent and quality of information differs between individual projects depending on the availability and extent of such data.

## 2.3 Infrastructure cluster evaluation

The analyses serve as superficial regional infrastructure overviews striving to identify business opportunities, of which 21 individual infrastructure clusters are defined, assessed, and presented in this report. These 21 infrastructure cluster assessments serve as first step to gain a broader understanding of the region. Further due diligence work is recommended to investigate detailed infrastructure needs and their potential interaction with development corridors on an individual project level within a cluster.

The cluster analyses focus on assessing regional infrastructure characteristics and investment needs to harness EU mineral supply chain opportunities in African regions. Clusters are defined based on spatial data of cross-border ECRM occurrences and of existing or planned African Strategic Development Corridors. Geographic Information System (GIS) software is used to visualise and analyse the data acquired, allowing strategic and pragmatic clusters to be identified. For the assessment, open-source data and spatial data provided by USGS, BRGM, LNEG, Giscoe, World Wide Fund for Nature, ArcGIS open source, as well as internal datasets from DMT are used. Furthermore, Thorn et al. (2022) created a comprehensive open-source database (available on Zenodo) of ongoing and planned infrastructure development corridors.

Clusters are defined based solely on quantitative data of regional ECRM occurrences. They do not consider a qualitative assessment of reserves and resources, nor the maturity stage of the individual ECRM occurrences. For example, a cluster rich in copper occurrences does not indicate that the respective country has various large-scale copper deposits or mines.

Each cluster is assessed by the following set of indicators to give a brief overview of the cluster and to evaluate the current state of infrastructure conditions within the defined region:

- Political stability
- ASM overview in the countries fully/partially encapsulated by the cluster. Data on ASM ECRM production mentioned in the cluster profiles are based on Vasters & Schütte (2023), unless noted otherwise.
- Overview of current mining sector
- Overview of processing facilities
- Road and shipping infrastructure
- Rail infrastructure
- Airport infrastructure
- Port infrastructure
- Energy infrastructure
- Communication infrastructure

### 2.4 Investment-related data beyond the scope of this report

As illustrated above, factsheets presented in this report cover information related to project economics, geology, ESG and, partly, infrastructure. It is important to note, though, that investment-related due diligence typically comprises additional input information and data evaluation. While these additional items were considered to be beyond the scope of the present report, the following brief overview presents a few exemplary questions and evaluation items that might be relevant to consider, among others, for such due diligence efforts. For more information, readers may consult Nederveen et al. (2023) and upcoming outputs related to AfricaMaVal work package 3, led by HCF International Advisers Ltd.

It is generally recommended to clarify and evaluate, among others:

- The different recipients, structure and synergies of project-related financing or investment, including funding provided to project developers/owners, their parent companies, service providers etc. From a match-making perspective, the identification of

these entities may help identifying the right type of stakeholder that may be approached for funding discussions. Clarifying the shareholder structure is also an important part of KYC risk assessments (e.g., to identify involvement of politically exposed persons).

- Participation of credible or otherwise desirable funding organisations in past or present project-related funding rounds, for instance certain public or private institutions (e.g., the European Investment Bank or private European banks) or government-backed debt guarantees (e.g., UfK debt guarantees), as these may potentially increase the credibility of the investment thesis and/or contribute to de-risking the project;
- Actual or potential changes in ownership (e.g., farm-in agreements) at the project or corporate level, their underlying market dynamics, and the extent how any such changes impact on the investment thesis, for instance, through potential shareholder dilution, change of control of a given project joint venture, or with regard to the availability of ECRM offtake capacities (note that project selection for this report avoided those project where close to 100% of anticipated production were publicly committed to offtake agreement at the time of data compilation – though this might have changed after completing work on a given factsheet);
- The financial strength/weakness of the project developer/operator/owner, based on market capitalisation, balance sheet, cash flow etc. Should include consideration of other assets held by the company and their impact on positive/negative cash flow; this also includes commitments to royalties, streaming arrangements etc.
- Strength and experience/track record of company management to successfully deliver comparable projects, ideally on time and on budget;
- Details on the project development timeline, including risks and uncertainties that may delay implementation progress and/or associated budget impacts. Details on country risk. Adequate reflection of project and country risk in economic modelling and valuation of the project, for instance, in terms of applying realistic discount rates.

## 2.5 Bibliography

Drobe, M. (2020): Vorkommen und Produktion mineralischer Rohstoffe - ein Ländervergleich. Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover. [https://www.bgr.bund.de/DE/Themen/Min\\_rohstoffe/Downloads/studie\\_Laendervergleich\\_2020.html](https://www.bgr.bund.de/DE/Themen/Min_rohstoffe/Downloads/studie_Laendervergleich_2020.html) (last accessed: 26.3.2024)

Nederveen, E., Lips, A., Albery, B., Kolorizos, C. (2023): Liquidity action plan. HCF International Advisers Ltd./AfricaMaVal project deliverable D3.1. <https://africamaval.eu/results/> (last accessed: 7.5.2024)

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USGS (2023): Mineral commodity summaries. <https://www.usgs.gov/publications/mineral-commodity-summaries-2023> (last accessed: 26.3.2024)

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WageIndicator (2024): Labour Rights Index – 2022. <https://labourrightsindex.org/heatmap-2022> (last accessed: 24.05.2024)

World Resources Institute (2024): Aqueduct – Water Risk Atlas. <https://www.wri.org/aqueduct> (last accessed: 24.05.2024)

### 3 Exploration projects

Mineral exploration is the key for maintaining and increasing primary ECRM production in line with the demand of the global energy transition. While Africa's mineral endowment is well known, the continent is overall underexplored. In terms of global exploration expenditure for key commodities such as copper, nickel or lithium, Africa has received a far lower share than other continents in recent years. Most African governments encourage exploration activities, not only in brownfield areas of known mineralisation, but also in greenfield areas whose resource potential is less well defined. Once an ore deposit has been discovered, activities switch from regional exploration to resource and reserve definition, initially to define a maiden resource estimate, which is then expanded and/or transformed to reserves by subsequent infill drilling or testing of adjacent satellite targets in case the mineralisation is open-ended.

Mineral exploration is associated with geological and project risks – a mineral occurrence rarely leads to the discovery of an ore deposit and, eventually, an economically viable mine. The risk progressively decreases as projects progress from the scoping to the pre-feasibility and, finally, the feasibility stage. At the same time, the costs for exploration, drilling and studies increases. Even at the feasibility stage, when already millions (up to above 100 million) of US\$ might have been spent, there is still a risk that a project may not be economically or technically viable. At the same time, the lead time from discovery to a mine entering into production has been steadily increasing. New mines opened in the 2020-2023 period had an average lead time of almost 18 years. This implies that investing in mineral exploration efforts, especially greenfield exploration, should not be expected to satisfy the short-term mineral demand but is nonetheless of critical importance for the mid- to long-term mineral supply perspective, since any mined reserves need to be replaced to avoid depletion. The more advanced project development is, the higher its chances to be brought into production in a shorter period of time.

For the purpose of this report, an exploration project refers to an early-stage project, with a certain level of project-specific information available. This implies, a maiden resource estimate, a scoping study, a preliminary economic assessment or a pre-feasibility study have been or will soon be completed. Projects that are at the feasibility stage have a higher chance for successful project development and are therefore included in the next chapter of 'mining projects.'

Still earlier-stage greenfield projects are not covered in this report since there would be insufficient information available to develop a meaningful project-specific factsheet. Such earlier-stage exploration approaches, including regional approaches, will be included in the general investment recommendations to be developed by BGR as part of their AfricaMaVal Task 7.6 and the associated Deliverable D7.3, which is due in early 2025.



### 3.1 Atlas Lion Pb-V hydrothermal vein project (Morocco)

Information as of 01/2024

#### 3.1.1 General project background

|                                    |                                                                                                                                                                                           |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Vanadium, lead                                                                                                                                                                            |
| <b>Other commodities</b>           | Niobium, tantalum                                                                                                                                                                         |
| <b>Location</b>                    | Fès-Meknès, Morocco<br>33°22' N, 3°28' W, 750 – 1,000 m.a.s.l.                                                                                                                            |
| <b>License type</b>                | 16 contiguous Vanadinite research licenses (256 km <sup>2</sup> ),<br>PR 3338361-PR 3338369, 33/267-33/273                                                                                |
| <b>License owner / operator</b>    | Ermazon S.A.R.L. (100 % Elcora Advanced Materials Corp. (public company)                                                                                                                  |
| <b>Contact</b>                     | 111 Ahmadi Crescent<br>Bedford, Nova Scotia B4A 4E5, Canada<br><a href="http://www.elcoracorp.com">www.elcoracorp.com</a><br><a href="mailto:info@elcoracorp.com">info@elcoracorp.com</a> |
| <b>Project status</b>              | Reserves Development                                                                                                                                                                      |
| <b>Possible production by 2030</b> | Yes, for initial production (small-scale)                                                                                                                                                 |



Figure 1. Atlas Lion project location, Morocco



### 3.1.2 Economic assessment

#### General project background:

The Atlas Lion area has already been mined for vanadinite by French companies in the 1950s. In the area, vanadium mineralisation occurs in the form of hydrothermal vanadinite veins that run east-west to southeast-northwest and are hosted by carbonate rocks, mainly limestones and limestones. The veins have a sub-vertical dip, several kilometres of strike length and mineable thicknesses of 0.30 to 1.0 m, which are often grouped parallel to each other in packages up to 40 m thick. Gangue quartz accounts for up to 50 cm thickness of the individual veins and is, besides vanadinite, further associated with the lead-bearing minerals cerrussite and galena. The company plans to initially operate a low-budget mining operation envisaging mining of near-surface vanadinite veins. The owner, Elcora through its 100 % subsidiary Ermazon, considers an initial mining phase, which aims at selling raw ore for lead only (average lead grade of 30 %). The revenue from the low-budget mining operation is planned to be used to finance an extensive exploration programme and a gravimetric concentration plant to process the vanadinite and concentrate the ore to a lead grade of around 55 %. The owner seeks investment for the implementation of the initial mining phase as well as for subsequent exploration, metallurgical test work (hydrometallurgical separation) and the construction of a concentrator.

#### Project description:

|                                    |                                                                                                                                                                                                                                                   |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Vanadinite polymetallic vein deposit                                                                                                                                                                                                              |
| NI 43-101 compliant resources      | 0.77 Mt @ 16 % $V_2O_5$ , 46 % Pb                                                                                                                                                                                                                 |
| Share of global vanadium resources | 0.11 % ( <i>USGS estimate global vanadium resources of 63 Mt</i> )                                                                                                                                                                                |
| Waste to ore ratio (whole orebody) | 1 (considered for stage 1 near-surface operation)                                                                                                                                                                                                 |
| Annual production                  | Stage 1 raw ore sale: 36 kt of ore, 5,700 t of contained $V_2O_5$ ,<br>Stage 2 concentrate sale: 60 kt of ore, 30 kt of concentrate<br>grading at 16 % $V_2O_5$ (9,500 t of contained $V_2O_5$ )<br>Stage 3: increased mine production considered |
| Life of mine                       | Not defined yet                                                                                                                                                                                                                                   |
| Investment required                | US\$ 1.23m (initial CAPEX for small-scale raw ore production)                                                                                                                                                                                     |
| Net present value (NPV)            | Insufficient economic data                                                                                                                                                                                                                        |
| Value addition potential           | The company plans the construction of a concentrator and a hydrometallurgical plant to produce lead and vanadium metal.                                                                                                                           |

#### Mining and processing:

- For the stage 1 mining phase, the company is planning open-pit mining using dozer, ripper, excavator and hydraulic hammer. Due to the fractured nature of the overburden rock formations, no drilling and blasting is planned at this stage. With this method, the operator is aiming to mine ~75 t/d of vanadinite ore for lead only at a waste to ore ratio of 3.3. The operator estimates the all-in operating costs to be US\$ 300/t of raw ore, including overburden removal.
- Stage 2 considers the construction of a semi-mobile gravimetric concentrator employing crushing, milling, rougher concentration with spirals and then application of Deister-tables to

produce a 50 % lead concentrate with 10 % vanadium. The company expects the all-in costs for the concentrator operation at US\$ 120/t of concentrate. The increase in concentrate sales revenue is calculated at ca. 70 % compared to the raw ore sales.

- Stage 3 envisages the implementation of a hydrometallurgical separation plant fed with the gravimetrically produced concentrate to produce lead and vanadium metal (both 99.99 % purity). The inventor and patent holder for the hydrometallurgical process gives a cost estimate of US\$ 700/t.

#### **BGR assessment and comments:**

- The deposit is a high-grade, low-tonnage vanadium project. The relatively shallow position of the mineralisation should allow for low waste mining. The estimated resource relates to one of at least a dozen areas explored and partially explored. Further exploration, particularly at depth, has the potential to expand the resource. Due to the vertical orientation of the vanadinite veins, the ratio of waste rock to ore will increase with increasing depth. A transition to underground mining should be considered in the economic assessment once a certain depth has been reached.
- Stage 3 estimates of concentrate costs relate to operating costs of US\$ 7,000/t of pure vanadium metal (10 % grade in the concentrate) plus 5 t of pure lead as a co-product. Due to the lead (current price around 2,200 US\$/t) the process is already paid by Pb production and the cash-costs would be negative. The current vanadium pentoxide flake (98 %) price is US\$ 17,380/t making the operation highly profitable.
- So far, the estimates of economic viability are based on the analysis of 14 samples extrapolated with the strike length and thickness of the vanadinite veins. It is recommended that this information from the operator can only be handled with care and might only apply for the stage 1 operation (near-surface, sale of raw ore).
- The project site can be accessed from Outat El Haj (~500 km east of Casablanca) via national route N4 to Tissaf. From the village a gravel road is heading east for ~20 km to the project site. All access from Tissaf is via unpaved roads not suitable for road trucks. Maintenance with grader/construction of dirt roads will be mandatory for haulage. Water must be obtained by drilling wells as close as possible to the mine site, preferably by drilling in the wadi (dry riverbed). There is no high-voltage grid near the license area, requiring power to be generated by diesel generators or solar and/or wind power in combination with diesel power.

### 3.1.3 ESG assessment

Due to the early stage of the project information on many ESG aspects and management practices are limited. No sustainability reports or ESG related company information is available on Elcoras website. To this point no issue could be identified that would preclude a responsible investment. However, several aspects needs verification in more detailed future studies. This applies in particular to the construction of the tailings storage facility (TSF).

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Environmental management                                           | No information on management available on company webpage; no reports on any incidents found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Efficient use of energy, renewable energy, GHG emissions reporting | No information on power demand available at this project stage; no grid power available within 50 km of the project, diesel generators and/or solar power plant required for power supply. The technical report recommends hydrometallurgical processing due to lower energy intensity compared to a pyrometallurgical approach.                                                                                                                                                                                                                                                                        |
| Water management and consumption                                   | Semi-arid climate with medium to high water stress; 517.2 mm average precipitation, wet season from January to March; high riverine flood risk. Process water supply may be realised by well drilling in local wadis; however, water consumption should be minimised (e.g. through high recycling rate) to avoid the risk of draining the aquifer during prolonged droughts.                                                                                                                                                                                                                            |
| Pollution prevention                                               | No information on specific planning of processing at this stage. Hydrometallurgical processing would assumedly comprise flotation as well as leaching, which are both associated with potential hazardous reagents requiring diligent handling. Pyrometallurgical processing would require adequate filter technique to prevent emission of contaminants e.g. lead to the air. Measures to prevent emission contaminants from tailings will be required in both cases. No specific information on AMD potential available; due to the carbonatic host rock acid buffer potential is assumed to be high. |
| Air quality                                                        | Remote area, no specific mitigation measures for dust suppression should be required; in case of pyrometallurgical processing filter systems are required to prevent emission of contaminants.                                                                                                                                                                                                                                                                                                                                                                                                          |
| Tailings management                                                | The technical report recommended the tailings to be pumped into sedimentation ponds and after dewatering excavation and dumping into a TSFs, which should be constructed into dry wadi valleys and covered with material from operation. Further investigation into the location of the TSF is highly recommended considering the risk of seasonal riverine flooding of the area.                                                                                                                                                                                                                       |
| Waste management                                                   | No information on waste management available at this project stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Hazardous materials management                                     | No information on hazardous materials management available at this project stage. Hydrometallurgical processing requires potentially hazardous reagents; assumed low risk anticipating diligent operation practice.                                                                                                                                                                                                                                                                                                                                                                                     |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Noise and vibration                                       | Remote area no special noise and vibration mitigation measures should be required.                                                                                                                                                                                                                                                                                                                                                                            |
| Protected areas and biodiversity                          | The project is not located in a Key Biodiversity area, but in n the Missouri et Outat El Haj permanent hunting reserve. Project area with semi-arid vegetation.                                                                                                                                                                                                                                                                                               |
| Mine closure                                              | No specific information on mine closure available at this project stage.                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Community health, safety and security                     | Next settlements are the City of Outat El Haj (~14,000 inhabitant (2004)) around 23 km west, and the villages of Tissaf (~10,000 inhabitant (2004)) and El Orjane (~7,500 inhabitants (2004)) around 12 km respectively 23 km west of the project area. Population is primarily of Berber tribes, no indication of settlements and significant economic activities in the project area itself. Negative impact on local population is assumed to be low risk. |
| Dialogue and engagement with communities and stakeholders | No information available at this project stage.                                                                                                                                                                                                                                                                                                                                                                                                               |
| Land acquisition and involuntary resettlement             | License area is state-owned property and shows no indication of significant settlements. It is unclear if there are economic activities in the area that might be impacted (e.g. pasture, hunting, tourism).                                                                                                                                                                                                                                                  |
| Occupational health & safety management                   | No information on OHS management at this project stage; remoteness of area will require provision of emergency services on site.                                                                                                                                                                                                                                                                                                                              |
| Workers' rights                                           | Morocco scores 79.5/100. Indication of previous ASM activities, no information on current situation.                                                                                                                                                                                                                                                                                                                                                          |
| Gender and diversity                                      | No information on gender and diversity policies available.                                                                                                                                                                                                                                                                                                                                                                                                    |
| Local value added and community development               | The project would create job opportunities in region with high unemployment rate (>20 %). 10 Dh/t royalties to be paid to the municipality; 20 % VAT and 30 % corporate taxes.                                                                                                                                                                                                                                                                                |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Legal compliance                                          | Exploration license valid until 2027. No indication of any breaches of law found.                                                                                                                                                                                                                                                                                                                                                                             |
| Management practices                                      | No specific information on management practice available on company webpage.                                                                                                                                                                                                                                                                                                                                                                                  |
| Transparency and reporting                                | Listed at TSXV; limited information for investors and reports on financial accounts and shareholder structure available.                                                                                                                                                                                                                                                                                                                                      |
| Business ethics                                           | Morocco scores 38/100 in the Corruption Perception Index. Morocco is not an EITI country. No ESG policies, code of conduct etc. on company website. No indication of any unethical practices found on the side of Elcora.                                                                                                                                                                                                                                     |

Table 5. ESG features of Atlas Lion project, Morocco

### 3.1.4 Further reading

Elcora Advanced Materials Corp. (2023): Corporate Presentation.

[https://www.elcoracorp.com/wp-content/uploads/2023/08/ELCORA-ERMAZON\\_Presentation\\_Generic\\_CVE\\_23-08-2023.pdf](https://www.elcoracorp.com/wp-content/uploads/2023/08/ELCORA-ERMAZON_Presentation_Generic_CVE_23-08-2023.pdf). (accessed: 30.01.2024)

Ermazon S.A.R.L. (2022): Atlas Lion Vanadinite Polymetallic Mineral Deposit. Form NI 43-101.

Technical Report and Resource Report. <https://www.elcoracorp.com/wp-content/uploads/2023/06/Ermazon-43-101-Atlas-Lion-Ni-43-101-Tech-Report.pdf>

(accessed: 30.01.2024)

## 3.2 Doornhoek carbonate-hosted fluorite project (South Africa)

Information as of 03/2024

### 3.2.1 General project background

|                                    |                                                                                                                                                                                                                                  |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodities</b>         | Fluorite (acid spar)                                                                                                                                                                                                             |
| <b>Location</b>                    | North-West, South Africa; 25°44' S, 26°10' E                                                                                                                                                                                     |
| <b>License type</b>                | Prospecting Right by DMRE: NW/30/5/1/2/2/10110                                                                                                                                                                                   |
| <b>License owner and Operator</b>  | SA Fluorite Pty Ltd.; Eurasian Resource Group ERG (majority shareholder)                                                                                                                                                         |
| <b>Contact</b>                     | ERG Management (RSA) (Pty) Ltd., 1 Sturdee Av., Lower Building, Rosebank, Johannesburg 2196<br><a href="https://www.eurasianresources.lu">https://www.eurasianresources.lu</a><br><a href="mailto:info@erg.net">info@erg.net</a> |
| <b>Project status</b>              | Pre-feasibility                                                                                                                                                                                                                  |
| <b>Possible production by 2030</b> | unlikely                                                                                                                                                                                                                         |

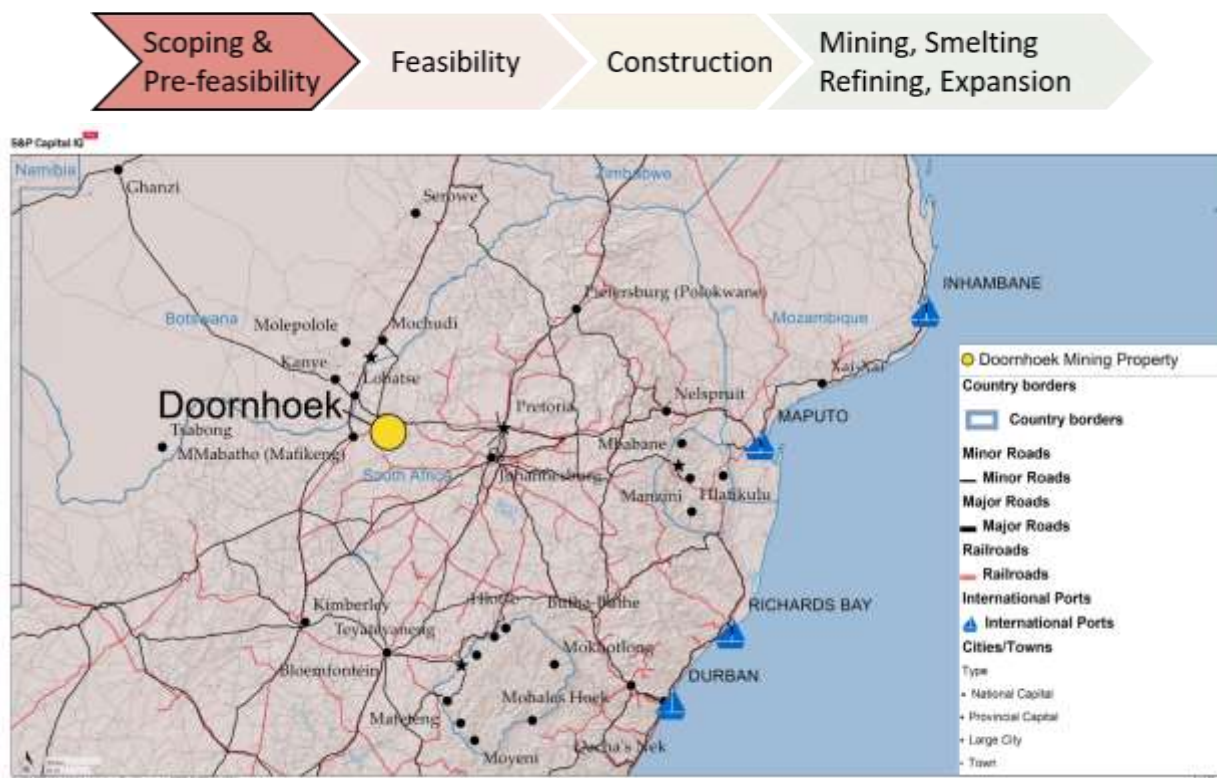


Figure 2. Doornhoek project location, South Africa

### 3.2.2 Economic assessment

#### General project background:

South Africa has the third largest fluorspar resources in the world after Mexico and China. According to its reserves, Doornhoek is said to be one of the largest deposits in the world. The Doornhoek license area with a size of 23,255 hectares is located in the North-West province, 250 km west of Pretoria and 15 km south of the Town of Zeerust. The prospecting right application is held 100 % by SA Fluorite (Pty) Ltd. Doornhoek is a high tonnage, medium grade Fluorite ( $\text{CaF}_2$ ) deposit, with an average grade of 14 %  $\text{CaF}_2$  within the ore. However, the fluorspar mineral product is of high quality with 97.8 %  $\text{CaF}_2$  and almost no detected deleterious elements, and can be therefore declared as high-quality acid spar. The mineralisation is hosted within stromatolitic stratabound dolomitic rocks of the mesoproterozoic Frisco carbonate formation (Transvaal Supergroup). Three mineralised horizons occur within the license area with a thickness from 2 m to a maximum of 32 m each. It is a very shallow ore body with a general dip of 4° to the east, from a surface outcrop to a maximum depth of 90 m. The deposit is tectonically fractured by several N-S faults. Due to the large announced reserves of 142 Mt of ore with almost 20 Mt of fluorite content, economic calculations showed a life of mine of at least 30 years. The mining right application to the Department of Mineral Resources and Energy (DMRE) is in progress as well as different marketing studies and the evaluation of offtake agreements with international companies. Initial metallurgical test works have been carried out, a preliminary economic assessment (NI 43-101 compliant) was completed and an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) report was submitted to the Department of Mineral Resources and Energy in 2017.

#### Project description:

|                                    |                                                                                               |
|------------------------------------|-----------------------------------------------------------------------------------------------|
| Ore deposit type                   | Carbonate hosted $\text{CaF}_2$ mineralisation (stratabound dolomites)                        |
| Proven mineral Reserves            | 142 Mt @ 14 % $\text{CaF}_2$ (non-code compliant)                                             |
| Share of global fluorite reserves  | 3.8 % ( <i>USGS estimate global <math>\text{CaF}_2</math> reserves of 280 Mt</i> )            |
| Total resources                    | 516.5 Mt @ 13.8 % $\text{CaF}_2$                                                              |
| Share of global fluorite resources | 1.4 % ( <i>USGS est. 5 bn. t world <math>\text{CaF}_2</math> resources</i> )                  |
| Waste to ore ratio                 | 3.8                                                                                           |
| Annual production                  | Annual production capacity: 280,000 t fluorspar                                               |
| Start-up & Life of mine            | 2028, 30 years                                                                                |
| Investment – total CAPEX           | No definitive information on CAPEX for mine development                                       |
| Net present value (NPV)            | No concrete data; only a short payback period and a positive NPV are mentioned by the company |
| Share of global fluorspar prod.    | 3.2 % (at full capacity)                                                                      |

#### Mining and processing:

- The very large and relatively flat-lying ore body allows opencast mining and the construction of a shallow open pit with a maximum depth of 90 m. Mining is based on drilling



and blasting, followed by hauling. It is planned to build stockpiles and to construct a new tailings dams as well as water supply dams, including a storm water dam. Ore and waste are loaded with excavators and transported with dump trucks. The strip ratio for the 1.5 Mtpa open pit scenario averages 3.8 waste to ore ratio over the mine life.

- Due to the large license area and the size of the orebody, pre-development of the project is expected to take at least five years before mining activities can commence. Therefore, a pre-production period of five to six years is expected, including processing plant construction, which will take two to three years.
- Initial metallurgical tests confirmed recovery rates of around 85 % acid spar. Acid spar is a metallurgically very clean mineral product with a very small to negligible proportion of deleterious elements.
- First processing steps are crushing, primary ball mill grinding and a slime pre-float circuit to remove talc and micas. This is followed by thickening and flotation. The raw fluorspar product undergoes multiple cleaning, regrinding and dewatering steps in cyclones. After this process, the concentrate grade should exceed 97 %  $\text{CaF}_2$  with impurities being below the specification limits of the offtake parties. The dewatering of the final concentrate will be done by vacuum filtration in a closed circuit to get an acid grade fluorspar filter cake with a moisture content of only 8-10 %  $\text{H}_2\text{O}$ .
- According to company calculations, at full production, the average tonnage of ore processed is around 124,000 tons per month. The average water consumption per tonne of ore processed was calculated at 0.94  $\text{m}^3/\text{ton}$  of ore, which is in the expected range of 0.7  $\text{m}^3/\text{t}$  to 1.2  $\text{m}^3/\text{t}$  for similar mining projects.

### **BGR assessment and comments:**

- The license area of Doornhoek is located about 15 km south of Zeerust (9,000 inhabitants) which is not an explicit mining town, but the urban area offers infrastructure in terms of transport routes and a stable electricity supply. Technical and professional services would also be available, as a certain amount of working staff.
- Doornhoek is a medium-grade but (very) high-tonnage fluorspar ( $\text{CaF}_2$ ) project. The mineral flotation product is a high quality calcium fluorite mineral, with a grade of 97.8 %  $\text{CaF}_2$  and without technically harmful impurities such as phosphorus, arsenic, etc. Therefore it is classified as an acid spar product (>97 %  $\text{CaF}_2$ ). The global demand for acid spar is high and will probably remain high in the future due to the increasing demand for fluorite chemicals, especially hydrofluoric acid.



- The geological situation and nature of the ore body is promising, as it is very shallow, crops out at the surface and extends to a maximum depth of 90 m within the license area, with a slight dip of 4° only, which is favourable for open cast mining. The deposit is tectonically fractured, but only slightly folded. However, the faults are unlikely to have a significant impact on the mine construction and on the opencast mining activities due to their small offset of around 3 m to a maximum of about 12 m.
- The long calculated life of mine of at least 30 years would have a very positive effect on the economy and the job situation of this relatively structurally weak region. Due to the extraordinarily large reserve this announced minimum live of mine could realistically be increased by another 10 to 20 years. This would provide interesting economic opportunities for future regional development.
- The water supply, especially groundwater for the project would pose a certain challenge. While the area is under extreme water stress, an agreement with surrounding farms to use groundwater is essential. Surface water such as rivers or lakes are rare in the area, except for the Nhalala River and the Klein-Maricopoort Dam in Zeerust for the regional water supply as well as small streams and ponds in the Molemane Eye Natural Reserve to the south.
- The ownership and the activities of Doornhoek are difficult to verify. The official owner is the ERG and the operator is SA Fluorite. Although the project is listed on ERGs website, there has been no update of the information since 2017.
- The Witkop fluorspar mine is located directly west of Doornhoek. Witkop is owned by Sallies Industrial Minerals Ltd. and the mine was active from 1971 until the 2000s. In 2023, Sallies reopened the mine for fluorspar extraction. In addition to fluorspar, dolomite is also being mined in the existing quarry for agricultural applications, industrial applications and the construction market. The tailings are also reprocessed for fluorspar extraction.

### 3.2.3 ESG assessment

Due to the early stage of the project, information on many ESG issues and evidence of responsible practice at project level is currently lacking. A final EIA report is available, and was submitted to the Department of Mineral Resources and Energy (Exigo 2017). No further information are available on the company's homepage. No major ESG issues were identified that would preclude responsible investment. However, the project is located in an area of effective area-based conservation measures and close to a terrestrial and Inland Waters protected area (<5km). Water management in the arid environment has been identified in the EIA (2017) as challenging, this is especially relevant because of the water intensive processing methods such as flotation.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Environmental Management                                           | ERG states that in Africa they continuously improve their environmental performance to develop, implement and manage environmental management systems compliant with national and relevant international standards. This includes ongoing efforts to align their existing management system with ISO 14001, however no relevant project information are available at the company's homepage. There is only access to the EIA report from 2017 (Exigo 2017).                                                                                                                                                              |
| Efficient use of energy, renewable energy, GHG emissions reporting | Electrical power from national grid ESKOM (mainly coal-based). ERG states that combination of wind, solar and bio energy could offer cost effective energy generation in the future. ERG reporting on GHG emissions (Scope 1 and 2) is related to the whole company with most operations in Kazakhstan.                                                                                                                                                                                                                                                                                                                  |
| Water management and consumption                                   | The mining site is located in an arid region with low water use. An Integrated Water Use Licence Application was submitted to the Department of Water and Sanitation (DWS) along with the Final EIA & EMP report on the 6th of February 2017. The EIA identified water efficiency as a major issue also in view of severe water shortage in local municipalities. The average water consumption per tonne of ore processed was calculated at 0.94 m <sup>3</sup> /ton of ore resulting an estimated (based on the data above) 1.4 million m <sup>3</sup> water per year. Preferred water supply resource is groundwater. |
| Pollution prevention                                               | Impact for acid mine drainage from mine residue facilities was rated negligible.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Air quality                                                        | Scarcely populated area, considered low risk. Wet suppression is feasible, but water intensive.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Tailings management                                                | Infrastructure to be set up includes Tailings Storage Facility, construction will commence in year four after the granting of a MR and EA including a Waste Management Licence and an Integrated Water Use Licence.                                                                                                                                                                                                                                                                                                                                                                                                      |
| Waste management                                                   | Sewage Treatment plant, water treatment plant and sludge treatment plant is envisaged.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Hazardous materials management                                     | Beneficiation process (flotation) considered low risk. It is foreseen that the development will generate solid construction waste, domestic and hazardous waste as well as sewage.                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Noise and vibration                                                | Noise and vibration from the pit and the plant is expected; scarcely populated area, considered low risk. Noise monitoring plan in place. Overburden dump can act as a noise barrier and visual screen between open pit and sensitive receptors.                                                                                                                                                                                                                                                                                                                                                                         |
| Protected areas and biodiversity                                   | The project is not located in a Key Biodiversity Area, but in the Marico Biosphere Reserve (UNESCO), an area of effective area-based conservation measures and close to (<5km) the Molemane Eye Nature Reserve, a terrestrial and Inland Waters protected area. However, the site is a historical mining area, the Witkop fluorspar mine is <10 km away.                                                                                                                                                                                                                                                                 |
| Mine closure                                                       | Final Life-of-Mine (LOM) closure liability for the mine without any progressive rehabilitation actions is estimated to be ZAR 102m (about € 5m, EIA 2017). In case of an immediate 'lights-out' closure event at the                                                                                                                                                                                                                                                                                                                                                                                                     |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | end of the first year of operation (year 8 after development started), the total financial provision required to successfully rehabilitate the mine is ZAR 20m (ca. € 1.02m). Generally, progressive rehabilitation is recommended as good international practice (if feasible).                                                                                                                                |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Community health, safety and security                     | The town Zeerust (ca. 9,000 inhabitants) is 15 km away, however potential negative impacts from the mine on local communities as noise, dust, etc. shall be kept as low as possible. Limited access to water is a major issue for communities. Water scarcity has, in a previous mining project near Groot Marico, resulted in social unrest.                                                                   |
| Dialogue and engagement with communities and stakeholders | According to the EIA report, public meetings were held with the opportunity to raise issues and comments in 2016. Focus Group meetings with landowners and relevant Government Department were held in 2016.                                                                                                                                                                                                    |
| Land acquisition and involuntary resettlement             | The direct surrounding of the mining site is scarcely populated and no relocations are required. The area is used for livestock farming and game hunting.                                                                                                                                                                                                                                                       |
| Occupational health & safety management                   | ERG states to provide a safe work environment and to avoid as far as is reasonably practicable adverse impact to the environment and the communities in which the company does business. This includes ongoing efforts to align their management system with OHSAS 18001, no project information is available at this stage.                                                                                    |
| Workers' rights                                           | South Africa scores 79/100 in the Labour Rights Index, means reasonable access to decent work. No further information available.                                                                                                                                                                                                                                                                                |
| Gender and diversity                                      | The company is committed to equal employment opportunity and to create fair working conditions free from discrimination and harassment on any grounds, including, but not limited to, race, religion or belief, gender, age, sexual orientation, physical disability.                                                                                                                                           |
| Local value added and community development               | Local value contribution is considered generally high, the site is located in an area of low economic development and high unemployment. Stimulation of employment and the local economy (net positive, though some loss of employment in agriculture, hunting and tourism expected), improved standard of living, skills development can be expected. Migrant workers are likely to be moving into the region. |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Legal compliance                                          | An Integrated Water Use Licence Application was submitted to the Department of Water and Sanitation (DWS) along with the Final EIA & EMP report on the 6th of February 2017. No indication of any breaches of law found.                                                                                                                                                                                        |
| Management practices                                      | The company states it adheres to relevant international guidelines such as the OECD Guidelines for Multinational Enterprises and strives to adherence with the International Council on Mining and Metals (ICMM) Mining Principles. Management practices of ERG differ depending on the country e.g. it is stated that all operations in Kazakhstan are certified to the ISO                                    |

| ESG category               | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | 14001 environmental management systems standard, operations in Africa not.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Transparency and reporting | The company operates privately. The company is not listed at any stock exchange. Sustainability policy available, sustainable development report published annually, no financial reports available.                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Business ethics            | South Africa scores 41/100 in the corruption perception index; South Africa is not an EITI country; ERG has a code of conduct in place as well as policies related to compliance, anti-bribery and anti-corruption and supplier code of conduct. ERG state they adhere to the OECD Due Diligence Guidance for Responsible Mineral Supply Chains and the Voluntary Principles on Security and Human Rights, also ERG provides a grievance mechanism and a whistleblower hotline. Several allegations related to human rights and environmental issues are listed against ERG (Business & Human Rights Resource Centre (2023)). |

Table 6. ESG features of Doornhoek project, South Africa

### 3.2.4 Further reading

Business & Human Rights Resource Centre (2023): DRC: Amnesty International's report reveals forced evictions, threats & intimidation of local communities in cobalt-rich areas, incl. co. responses. <https://www.business-humanrights.org/en/latest-news/drc-amnesty-international-and-a-local-ngo-shed-the-light-on-the-disastrous-impacts-of-industrial-scale-mining-on-communities-rights/> (accessed 08.04.2024)

EXIGO (2017): Doornhoek fluorspar mine: FINAL EIA & EMPR. [https://sahris.sahra.org.za/sites/default/files/additionaldocs/2017-02-03%20Doornhoek%20Final%20EIA%26EMPR\\_4.pdf](https://sahris.sahra.org.za/sites/default/files/additionaldocs/2017-02-03%20Doornhoek%20Final%20EIA%26EMPR_4.pdf) (accessed 08.04.2024)

Urban Econ Development Economists (2016): Environmental impact assessment for Doornhoek fluorspar mine project – Socio-economic impact study. <https://sahris.sahra.org.za/sites/default/files/additionaldocs/Appendix%207.1%20SEIA.pdf> (accessed 03.04.2024)

### 3.3 Eureka REE carbonatite project (Namibia)

Information as of 05/2023

#### 3.3.1 General project background

|                                    |                                                                                                                                                                                                                                                               |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Neodymium and praseodymium                                                                                                                                                                                                                                    |
| <b>Other commodities</b>           | Other light rare earth elements (LREE)                                                                                                                                                                                                                        |
| <b>Location</b>                    | Erongo region, Namibia<br>22°02' S, 15°15' E, 1,200 m.a.s.l.                                                                                                                                                                                                  |
| <b>License type</b>                | Prospecting licenses EPL 8748 and EPL 6762 (165.2 km <sup>2</sup> )                                                                                                                                                                                           |
| <b>License owner / operator</b>    | E-Tech Resources Inc. (public company)                                                                                                                                                                                                                        |
| <b>Contact</b>                     | Purdy's Wharf Tower II<br>Suite 2001, 1969 Upper Water Street<br>Halifax, Nova Scotia B3J 3R7, Canada<br><a href="http://www.etech-resources.com">www.etech-resources.com</a><br><a href="mailto:contact@etech-resources.com">contact@etech-resources.com</a> |
| <b>Project status</b>              | Active exploration, maiden Mineral Resource Estimate (09/2021), Prefeasibility Study in progress                                                                                                                                                              |
| <b>Possible production by 2030</b> | unlikely                                                                                                                                                                                                                                                      |

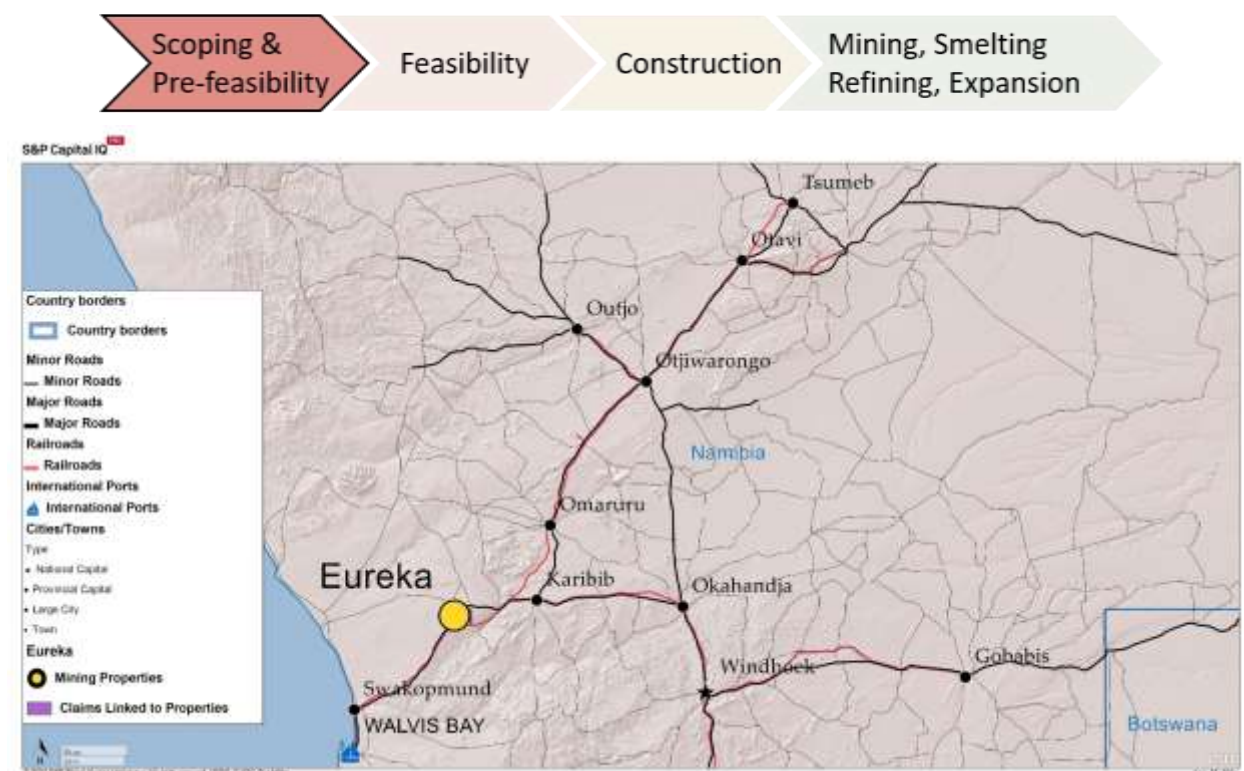


Figure 3. Eureka project location, Namibia

### 3.3.2 Economic assessment

#### General project background:

The Eureka project is located within the Southern Central Zone of the Neoproterozoic Damara Belt. First exploration on rare earth elements (REE) mineralisation was conducted in the 1980s, but without subsequent mining. The mineralisation is hosted by steeply dipping, E-W to NW-SE trending carbonatite dykes (17 identified) with a combined strike length of over 1,200 m, a depth of at least 60 m (drill-tested), and a thickness ranging between 0.5 to 5 m (averaging 2 m). These dykes show a variable abundance of the coarse-grained REE-hosting mineral monazite and can be mined near surface. The owner E-Tech Resources is seeking investment for assaying already available trench and drilling samples, diamond drilling (both infill and expansion) and continued metallurgical testwork.

#### Project description:

|                                    |                                                                                                                                                                                                                                           |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Carbonatite (fresh)                                                                                                                                                                                                                       |
| JORC compliant resources           | 0.31 Mt @ 4.8 % REO, 0.7 % NdPrO (inferred)                                                                                                                                                                                               |
| Waste to ore ratio (whole orebody) | Relatively low due to expected selective extraction of near-surface mineralisation                                                                                                                                                        |
| Annual production                  | 4,800 – 6,000 t concentrate including 2,832 – 3,540 t REO, 0.1 Mt of ore ( <i>BGR estimate including 6000 t @ 59 % REO, ore grade of 4.8 % and 65 % recovery; major discrepancy to the annual production of 3 Mt/a stated by E-Tech</i> ) |
| Share of global REO production     | 1.3 % (considering 3,540 t REO/a)<br>( <i>USGS estimate global REO production of 280,000 t</i> )                                                                                                                                          |
| Investment required                | ~US\$ 1.9m (for Phase 1 further exploration, resource updates and continued metallurgical testwork completion, see below)                                                                                                                 |
| Total in-situ value                | US\$ 744m ( <i>S&amp;P Capital IQ estimate based on value of total mineable product identified as inferred resources</i> )                                                                                                                |
| Value addition potential           | E-Tech signed a Memorandum of Understanding (05/2023) with Ondoto Rare Earth and Namibia Critical Metals to conduct a feasibility study for a REE separation plant in Namibia.                                                            |

#### Mining and processing:

- Conventional open pit methods employing drilling, blasting, and hauling over multiple fresh carbonatite dykes with a combined strike length of over 1,200 m and located in four zones are expected. It is assumed that mining will focus on selective extraction, rather than particularly high production rates, to minimise dilution of the mineralised carbonatite dykes with waste rock.
- Metallurgical tests included crushing and grinding for monazite liberation as well as subsequent gravity and magnetic separation. The testwork programme resulted in the recovery of 65 % rare earth oxides (REO) to gravity concentrate and a 59 % REO grade after subsequent magnetic separation. Further grinding and flotation of the middlings and tailings streams are considered to improve recovery.



- The consulting company SRK assumed mining expenditures of US\$ 5/t ore and processing costs at the gravity plant of US\$ 25/t ore milled. SRK calculated a concentrate value (exclusive of duties, taxes, and royalties) of US\$ 2,440/t, which relates to US\$ 132/t of ore.

### **BGR assessment and comments:**

- The deposit is a medium- to high-grade, low-tonnage REO project. The shallow position of the mineralisation and the distinct visual discrimination between economic fresh carbonatite and the thin altered dyke selvages (below the cut-off) should allow selective mining.
- Previous exploration has only been carried out on approximately 1/3 of the orebody volume due to the restricted license, but has already identified 17 prospect targets. The acquisition of the new exploration license now authorizes E-Tech to explore the entire orebody (~56 km<sup>2</sup>), which holds the potential to expand resource estimates. SRK estimates this expansion might add another 0.5 to 1.5 Mt of ore @ 2-5 % REO. This might increase the life of mine to 8-18 years.
- It is important to note that current resource estimates relate to inferred mineral resources only. Inferred mineral resources have a low level of confidence by definition, and infill drilling with better quality sampling is required to increase the level of confidence and classify indicated mineral resources in order to advance the project to a prefeasibility study. Usually only a certain percentage of inferred resources can be transferred to indicated resources.
- E-Tech plans to deploy ~US\$ 1.9m for the completion of Phase 1 including further exploration (infill and extension drilling, trenching), resource updates and continued metallurgical testwork. Phase 2 might include the completion of a prefeasibility study and will require further investments.
- During metallurgical testing, monazite concentrate was produced yielding a specific radioactivity of 18.7 Bq/g. Material above 10 Bq/g must be transported in certain containers (e.g., steel drums) or blended to reduce the detectable dose, e.g., with magnetite. Both ways would increase shipping costs.
- The Eureka project is located ~35 km E of Usakos (~3,500 inhabitants) and connected within 2 km via the Trans-Kalahari highway and within 4 km via railway to the capital Windhoek as well as port facilities at Walvis Bay. High tension, 200 kV AC, power lines run close to the Project, with a substation approximately 10 km to the south southeast.
- Local labour may be sourced either from the farms within the permit area, or from the larger towns of Usakos and Swakopmund. Skilled professionals and drilling and exploration services are readily available within the country due Namibia's strong affiliation towards mining.

### 3.3.3 ESG assessment

Due to the early stage of the project detailed information on several ESG issues are currently missing. However, overall no major ESG risks were identified that could not be handled by state of the art management practice. However, the Th/U content, which is not planned to be separated from the concentrate, could be a relevant issue. Regarding shipment restrictions, the company states the risk as low due to the on average low content in the ore. However, a potential buyer will have to handle the disposal of the radioactive residues after leaching the concentrate.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                          |
| Environmental management                                           | No reports on incidents found. Company is committed to safety and environmental policy to adhere to environmental laws and reduce the environmental impact; emergency response plans are mandatory for every operation.                                                                                                                                                                                  |
| Efficient use of energy, renewable energy, GHG emissions reporting | No specific information on energy use available at this stage; the Namibian national grid is highly dependable on oil as energy source and imports from the coal reliant South African grid.                                                                                                                                                                                                             |
| Water management and consumption                                   | Project site in arid area with low water use; medium to high riverine flood risk. No specific information on water consumption available at this stage; planned mining and processing technology probably not associated with high water consumption.                                                                                                                                                    |
| Pollution prevention                                               | Th/U content in REE deposits implies natural radioactivity and associated risks; the company is stating a below average Th/U grade (400 ppm ThO <sub>2</sub> ) compared to other REE deposits. Planned processing technology comprise gravitational concentration and magnetic separation; the Th/U content will mainly report to the recovered monazite concentrate.                                    |
| Air quality                                                        | Remoteness of site location does not indicate general need for special measures. Th/U content is not planned to be separated from the concentrate at the mine site (see “Hazardous materials management”), thus no special care to prevent dust discharge necessary.                                                                                                                                     |
| Tailings management                                                | A dedicated tailing storage facility is not necessary with the planned processing technology.                                                                                                                                                                                                                                                                                                            |
| Waste management                                                   | Selective mining approach is envisaged to minimise waste rock.                                                                                                                                                                                                                                                                                                                                           |
| Hazardous materials management                                     | As the Th/U content will mainly remain in the monazite concentrate, the risk of radioactive residues is rated low. However, shipment of the monazite concentrate might be problematic due to radioactivity and a potential buyer of the concentrate should apply state of the art practices handle the radioactive residues. Due to the below average Th/U content the company states this risks as low. |
| Noise and vibration                                                | Conventional drilling and blasting operation; possible problems for local residents considered low risk due to remote site location.                                                                                                                                                                                                                                                                     |
| Protected areas and biodiversity                                   | The project is not located in or close to any key biodiversity areas or other designated protected areas.                                                                                                                                                                                                                                                                                                |



| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mine closure                                              | The company is committed to assess the mine closure costs on annually base and reserve appropriate financial resources.                                                                                                                                                                                                                                    |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                            |
| Community health, safety and security                     | Scarcely populated area; Mine site in the vicinity of the town of Usakos (~3,500 inhabitants, ~13,300 in the constituency of Karibib); few smaller settlements in or close to the mining area; distance to the nearest major settlements appears large enough that the potential negative impact on the local population is generally considered low risk. |
| Dialogue and engagement with communities and stakeholders | Focus on engagement with local communities and the government concerning ESG / CSR measures is stated as a short-term milestone.                                                                                                                                                                                                                           |
| Land acquisition and involuntary resettlement             | No specific information at this stage; resettlement of smaller settlements might be necessary.                                                                                                                                                                                                                                                             |
| Occupational health & safety management                   | No specific information on OHS management available at this stage.                                                                                                                                                                                                                                                                                         |
| Workers' rights                                           | Namibia scores 68.5/100 in the Labour Rights Index. No indication of non-compliance with fundamental workers' rights found.                                                                                                                                                                                                                                |
| Gender and diversity                                      | The company is committed to provide equal opportunities and value diversity; no evidence of practice at this stage.                                                                                                                                                                                                                                        |
| Local value added and community development               | No specific information on CSR available at this stage; engagement with stakeholders on CSR measures stated as short-term goal. The currently low amount of resources leads to an expected short life of mine with limited long-term development opportunities for the local economy; as exploration is still ongoing resources may increase.              |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                            |
| Legal compliance                                          | No indication of any breaches of law found. Exploration permit granted.                                                                                                                                                                                                                                                                                    |
| Management practices                                      | Development of management policies ongoing due to early stage; no indication of poor management practices so far.                                                                                                                                                                                                                                          |
| Transparency and reporting                                | Listed on the TSX Venture Exchange (TSXV) and the Frankfurt Stock Exchange (XFRA). Member of the Rare Earths Industry Association (REIA), Critical Minerals Association (CMA), European Raw Materials Alliance (ERMA).                                                                                                                                     |
| Business ethics                                           | Namibia scores 49/100 in the corruption perception index; Namibia is not an EITI country; no indication of unethical practices found.                                                                                                                                                                                                                      |

Table 7. ESG features of Eureka project, Namibia

### 3.3.4 Further reading

E-Tech Resources (2021): Code of Business Conduct and Ethics. <https://etech-resources.com/wp-content/uploads/2022/09/E-Tech-Code-of-Conduct-adopted-20211015.pdf> (accessed 20.05.23)

E-Tech Resources (2021): Safety and Environmental Policy. <https://etech-resources.com/wp-content/uploads/2022/09/E-Tech-Safety-and-Environmental-Policy-adopted-20211015.pdf> (accessed 20.05.23)

E-Tech Resources (2022): E-Tech Resources Inc. commits to Rare Earths Sustainability Initiatives. <https://etech-resources.com/e-tech-resources-inc-commits-to-rare-earths-sustainability-initiatives/> (accessed 20.05.23)

E-Tech Resources (2023): E-Tech Resources Expands Mineral Landholdings at the Eureka REE Project. <https://www.newsfilecorp.com/release/160184> (accessed 16.05.23)

Numus Financial (2023): E-Tech Resources Inc. - Initiating Coverage Report. <https://numusfinancial.com/wp-content/uploads/2023/01/E-Tech-Resources-Company-Report-F.pdf> (accessed 16.05.23)

SRK Consulting (2021): Independent Technical Report, Eureka Rare Earth Project, Namibia. <https://etech-resources.com/wp-content/uploads/2021/09/Eureka-NI43-101.pdf> (accessed 16.05.23)

### 3.4 Ewoyaa Li pegmatite project (Ghana)

Information as of 03/2023

#### 3.4.1 General project background

|                                    |                                                                                                                                                                                                                                                                   |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Lithium                                                                                                                                                                                                                                                           |
| <b>Other commodities</b>           | Tin, tantalum, niobium (not considered for resource)                                                                                                                                                                                                              |
| <b>Location</b>                    | Central region, Ghana<br>5°14' N, 1°10' W, 20 – 120 m.a.s.l.                                                                                                                                                                                                      |
| <b>License type</b>                | Exploration license (560 km <sup>2</sup> )<br>Mining license submitted (expected for Q3 2023)                                                                                                                                                                     |
| <b>License owner / operator</b>    | Atlantic Lithium Ltd. (former IronRidge Resources Ltd.)<br>(public company)                                                                                                                                                                                       |
| <b>Contact</b>                     | Australia Square, Level 33, 264 George Street<br>Sydney, New South Wales 2000, Australia<br><a href="https://www.atlanticlithium.com.au/">https://www.atlanticlithium.com.au/</a><br><a href="mailto:info@atlanticlithium.com.au">info@atlanticlithium.com.au</a> |
| <b>Project status</b>              | Pre-feasibility study completed (09/2022)                                                                                                                                                                                                                         |
| <b>Possible production by 2030</b> | Company projection: 2026                                                                                                                                                                                                                                          |

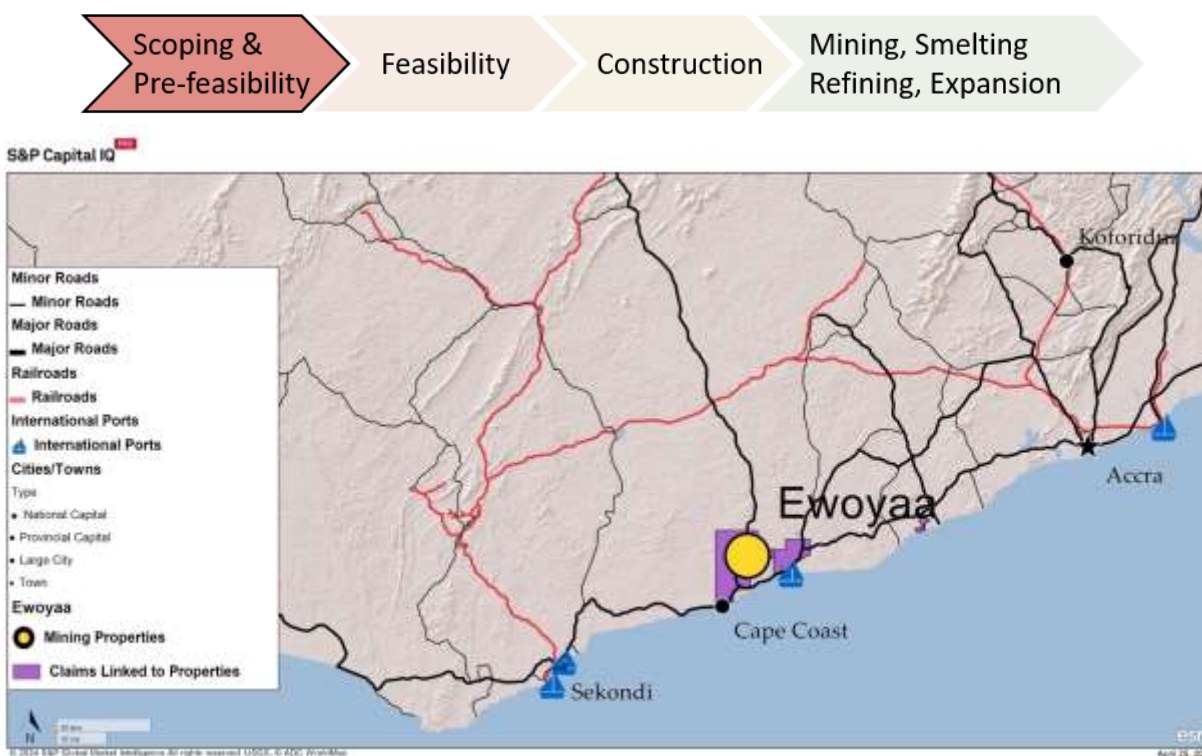


Figure 4. Ewoyaa project location, Ghana

### 3.4.2 Economic assessment

#### General project background:

The Ewoyaa project includes the spodumene-lithium pegmatite deposits of Ewoyaa, Anokyi, Grasscutter, Abonko, and Kaampakrom. Mineralised pegmatite intrusions occur as sub-vertical bodies hosted in two dominant pegmatite trends (i) the roughly N-S oriented pegmatite array of the "Ewoyaa trend" and (ii) the roughly WNW-ESE trending intrusive swarm arrays of the "Abonko trend". The ore bodies vary in thickness, at Abonko and Kaampakrom between 4 m and 12 m, and at Ewoyaa Main between 30 - 60 m. The pre-feasibility study for the Ewoyaa project was completed in 2022/09 considering an annual production of 255,000 t 6 % lithium spodumene concentrate and, additionally, an ore fines product and a feldspar by-product. Atlantic Lithium expects the Definitive Feasibility Study (DFS) to be released in Q2 2023. The owner seeks investment to bring the crushing system in-house and to face the increased resource footprint, including, e.g., the extended high-voltage power line re-alignment.

#### Project description:

|                                       |                                                                                                                                  |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                      | Pegmatite                                                                                                                        |
| JORC compliant reserves, lithium only | 18.9 Mt @ 1.24 % Li <sub>2</sub> O                                                                                               |
| Share of global lithium reserves      | 0.4 % ( <i>USGS estimate global Li<sub>2</sub>O reserves of 56 Mt</i> )                                                          |
| JORC compliant resources              | 35.3 Mt @ 1.25 % Li <sub>2</sub> O (reserves included)                                                                           |
| Share of global lithium resources     | 0.2 % ( <i>BGR estimate* global Li<sub>2</sub>O resources of 211 Mt</i> )                                                        |
| Waste to ore ratio (whole orebody)    | 8                                                                                                                                |
| Annual production                     | 2 Mt of ore, 255,000 t 6 % lithium spodumene conc. (SC6), (32,941 t of contained Li <sub>2</sub> O)                              |
| Life of mine                          | 12.5 years                                                                                                                       |
| Investment required                   | US\$ 125m for mine construction (including US\$ 70m covered by a funding agreement with Piedmont Lithium Inc.)                   |
| Net present value (NPV)               | US\$ 1.33bn (based on SC6 price of US\$ 1,359/t and 8 % discount rate)                                                           |
| Share of global lithium production    | 11.8 % (32,941 t Li <sub>2</sub> O/a, recovery 62.5 %) ( <i>USGS estimate global Li<sub>2</sub>O production of 280,000 t</i> )   |
| Value addition potential              | A saleable direct shipping ore fines product ("DSO fines"; total of ~3.7 Mt) and a saleable feldspar by-product (total of ~4 Mt) |

#### Mining and processing:

- Four geometallurgical domains include coarse-grained, higher-grade P1 type and finer-grained, lower-grade P2 type pegmatites and their weathered and fresh equivalents. Conventional open pit methods employing drilling, blasting, and hauling over five mining areas in 14 pits envisaging an ore production rate of 2 Mt/a, prioritising P1 material feed over P2, and expecting an average waste to ore ratio of 8. During the first 5 years of operation, Atlantic Lithium considers a waste to ore ratio of 5.2, increasing as mining progresses into the deeper parts of the pegmatite bodies.

- Spodumene is concentrated via crushing (designed to produce a top-size of 10 mm), envisaging a gravity-only plant to achieve the production of 6 % Li<sub>2</sub>O spodumene concentrat (SC6) (containing <1 % Fe<sub>2</sub>O<sub>3</sub> and <3 % total alkalis) as well as DSO fines (~1 mm) and a feldspar by-product. High intensity magnetic separation applied on the feldspar product lead to lowered Fe<sub>2</sub>O<sub>3</sub> contents to 0.04 % and increased the (Na<sub>2</sub>O+K<sub>2</sub>O) contents to 10.2 %.
- The operating expenditures are given at US\$ 278/t SC6 including a discount of US\$ 165/t for by-products processed free-on-board (FOB) Ghana port. This is within an expectable range for a high tonnage operation.

#### BGR assessment and comments:

- The deposit is a high-grade, medium-tonnage project with an expected high waste to ore ratio of 8. Resource expansion seems possible by assessing all mineralised pegmatites, both within and beyond the currently targeted pegmatite bodies. This yields the potential for exploration upside and extending the mine life well beyond 12.5 years, which is positive for the development of the region.
- Atlantic Lithium assumes high SC6 FOB Ghana port of US\$ 1,359/t. The average SC6 price for the last 5 years was ~US\$ 1,200/t, with a peak of US\$ 2,730/t end of 2022 reflecting the high volatility of lithium concentrate prices. BGR considers Atlantic Lithium's price estimate to be reasonable and the envisaged by-products to be valuable.
- The mining plan is based on the production of 75.5 % of indicated resources and 24.5 % of inferred resources (both JORC compliant). Geological confidence in the inferred mineral resources is low and there is no certainty that further exploration will result in the determination of the indicated mineral resources or that the production target can be realised. However, Atlantic Lithium states that the project cash flow would remain positive on an annual basis even if the Inferred resources were moved to waste and all mining and processing costs for the Inferred resources were incurred over the life of mine.
- Ewoyaa is connected to operational infrastructure including 1 km north from the Takoradi - Accra N1 (bitumen) highway via Cape Coast, 110 km from the Takoradi deep-sea port (near Secondi) and adjacent to hydroelectric sourced grid power. Water is supplied via a pipeline from Lake Agege (7 km north of the water storage dam).
- The Project is funded under a co-development agreement made with Piedmont Lithium Inc., where Piedmont has the right to earn up to 50 % at the project level and 50 % SC6 offtake at lithium market price rates by funding US\$ 17m towards studies and exploration and US\$ 70m towards mine CAPEX. Offtake shall then be shipped to the 100 % Piedmont Lithium-owned Tennessee Processing Facility (USA) for LiOH production. In addition, the Government of Ghana has the right to a 10 % free carry once in production.

### 3.4.3 ESG assessment

Due to the early stage of the project detailed information on several ESG issues are currently missing. However, no major ESG risks were identified that could not be handled by state of the art management practice. The relatively extensive settlement areas on the exploration concession call for careful stakeholder engagement at an early stage to avoid potential conflicts.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                      |
| Environmental management                                           | No reports on incidents found. Company states it is developing an ESG policy.                                                                                                                                                                                                                                                                                                                        |
| Efficient use of energy, renewable energy, GHG emissions reporting | National grid highly dependent on oil and natural gas; hydroelectric power plant in proximity.                                                                                                                                                                                                                                                                                                       |
| Water management and consumption                                   | Project site in humid area with medium to high water stress; probable process technology not excessively water intensive. Riverine flood risk extremely high.                                                                                                                                                                                                                                        |
| Pollution prevention                                               | Information on the deposit specific geochemistry not available; pegmatite deposits are not particularly risky in this context.                                                                                                                                                                                                                                                                       |
| Air quality                                                        | Conventional drilling and blasting mining and tailings disposal requires dust suppression measures, especially considering proximity to settlements.                                                                                                                                                                                                                                                 |
| Tailings management                                                | No information on planned tailings facilities and management available at this stage. Comparable projects employing flotation technology; the necessity of a TSF is likely.                                                                                                                                                                                                                          |
| Waste management                                                   | Average mine waste to ore ratio is high (8:1); the company's waste handling during exploration indicates responsible management practices.                                                                                                                                                                                                                                                           |
| Hazardous materials management                                     | Anticipated processing (crushing, gravity and magnetic separation) technology does not include hazardous chemicals.                                                                                                                                                                                                                                                                                  |
| Noise and vibration                                                | Conventional drilling and blasting mining requires mitigation measures (low-impact sequential blasting).                                                                                                                                                                                                                                                                                             |
| Protected areas and biodiversity                                   | The Brimso forest reserve (IUCN category IV) is located in the vicinity of the exploration license area in the west; as the mining license area will be of smaller extent future conflict is not assumable.                                                                                                                                                                                          |
| Mine closure                                                       | No specific information on mine closure at this stage; remediation measures during exploration activities indicate responsible management practices.                                                                                                                                                                                                                                                 |
| <b>Social and socio-economic issues</b>                            |                                                                                                                                                                                                                                                                                                                                                                                                      |
| Community health, safety and security                              | The exploration license borders on the cities of Cape Coast (~170,000 inhabitants) and Mankessim (~40,000 inhabitants); several smaller towns and villages are located in the area. As specific information on mine location, extent, and applied technology are not available at this stage, detailed estimation of impacts is not yet possible, but need special attention in this populated area. |



| ESG category                                                                                                                                | Assessment                                                                                                                                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dialogue and engagement with communities and stakeholders  | No specific information on community engagement available at this stage; widespread settlement calls for a careful approach at an early project stage to prevent future conflicts.                                                                                                                  |
| Land acquisition and involuntary resettlement                                                                                               | Final area of the mining license not yet determined; resettlements of smaller settlements probably necessary.                                                                                                                                                                                       |
| Occupational health & safety management                                                                                                     | No specific information on OHS management available at this stage.                                                                                                                                                                                                                                  |
| Workers' rights                                                                                                                             | Ghana scores 59.5/100 in the Labour Rights Index. No indication of non-compliance with fundamental workers' rights found.                                                                                                                                                                           |
| Gender and diversity                                                                                                                        | Diversity Policy for company staff is in place; no specific figures for operation in Ghana reported so far.                                                                                                                                                                                         |
| Local value added and community development                                                                                                 | Possible resources extension could extend the currently planned mine life of 12.5 years enabling longer-term community development. Feldspar by-product may enable further local business opportunities. No specific information on planned community development measures available at this stage. |
| <b>Governance</b>                                                                                                                           |                                                                                                                                                                                                                                                                                                     |
| Legal compliance                                                                                                                            | No indication of any breaches of law found. Acquisition of the necessary licenses part of the upcoming feasibility study.                                                                                                                                                                           |
| Management practices                                                                                                                        | Company states it is developing an ESG policy.                                                                                                                                                                                                                                                      |
| Transparency and reporting                                                                                                                  | Company with registered office in Sydney; listed at ASX; financial reporting is according to stock market requirements.                                                                                                                                                                             |
| Business ethics                                                                                                                             | Ghana scores 43/100 in the corruption perception index; Ghana is an EITI member country; no indication of unethical corporate practices found; Anti-Bribery and Corruption Policy on company level is in place.                                                                                     |

Table 8. ESG features of Ewoyaa project, Ghana

### 3.4.4 Further reading

Atlantic Lithium (2022a): Pre-Feasibility Study Delivers Robust Project Economics Ewoyaa Lithium Project, Ghana, West Africa

<http://ir.q4europe.com/Tools/newsArticleHTML.aspx?solutionID=3674&customerKey=IronRidge&storyID=15558113> (accessed 13.03.23)

Atlantic Lithium (2022b): Annual Report Corporate Governance Summary

<https://www.atlanticlithium.com.au/s/202209-Corporate-Governance-Statement-Website-Version-ALL2773.pdf> (accessed 27.03.23)

Atlantic Lithium (2023a): Ewoyaa Lithium Resource Increases to 35.3Mt at 1.25 % Li<sub>2</sub>O Measured and Indicated Resources Now 79 % of Total Resource Cape Coast Lithium Portfolio, Ghana, West Africa.

<http://ir.q4europe.com/Tools/newsArticleHTML.aspx?solutionID=3674&customerKey=IronRidge&storyID=15680607> (accessed 13.03.23)

Atlantic Lithium (2023b): Corporate Update Quarterly Activities and Cash Flow Report for the quarter ended 31 December 2022

<http://ir.q4europe.com/Tools/newsArticleHTML.aspx?solutionID=3674&customerKey=IronRidge&storyID=15677897> (accessed 13.03.23)



### 3.5 Green Giant V (-graphite) project (Madagascar)

Information as of 01/2024

#### 3.5.1 General project background

|                                    |                                                                                                                                                                                                                                                        |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Vanadium                                                                                                                                                                                                                                               |
| <b>Other commodities</b>           | Graphite                                                                                                                                                                                                                                               |
| <b>Location</b>                    | Toliara, Madagascar<br>23°59' S, 45°02' E, 500 – 550 m.a.s.l.                                                                                                                                                                                          |
| <b>License type</b>                | Research permits: Green Giant blocks (188 km <sup>2</sup> ) and<br>Ilanapera (37 km)                                                                                                                                                                   |
| <b>License owner / operator</b>    | NextSource Materials Inc. (public company)                                                                                                                                                                                                             |
| <b>Contact</b>                     | Exchange Tower, Suite 1940, 130 King Street West<br>Toronto, Ontario M5X 2A2, Canada<br><a href="http://www.nextsourcematerials.com">www.nextsourcematerials.com</a><br><a href="mailto:info@nextsourcematerials.com">info@nextsourcematerials.com</a> |
| <b>Project status</b>              | Reserves Development - Prefeasibility/Scoping                                                                                                                                                                                                          |
| <b>Possible production by 2030</b> | unlikely                                                                                                                                                                                                                                               |

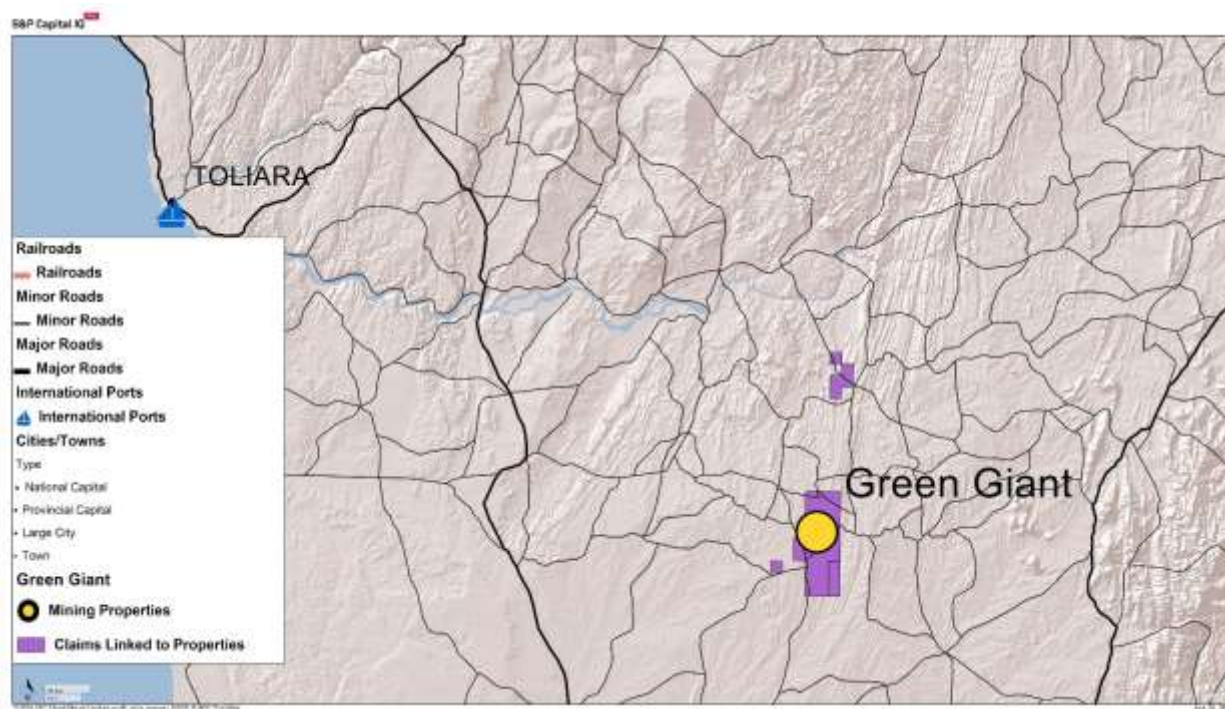


Figure 5. Green Giant project location, Madagascar

### 3.5.2 Economic assessment

#### General project background:

The owner NextSource Materials (formerly Uranium Star Corp. and Energizer Resources Inc.) first explored the project area in 2007. The property is underlain by metamorphosed supracrustal and plutonic rocks of Late Neoproterozoic age that are deformed with upright north northeast-trending structures. The vanadium deposits on the Green Giant property, namely Jaky, Manga and Mainty, are subdivided into two types of mineralisation, (1) weathered and oxidised graphite-phlogophite schists with kaolinite clay, jarosite, and goethite and (2) primary graphite-phlogophite schists with jarosite and pyrite. Both the Jaky and Mainty zones were found to extend at surface for over 1 km in length each, with the Jaky zone having a width in excess of 200 m, while the Mainty zone exceeds widths of 100 m. The owner has not announced any plans to explore or develop Green Giant during the next three years.

#### Project description:

|                                    |                                                                                                                                                                                                                   |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Shale-hosted carboniferous vanadium deposit                                                                                                                                                                       |
| NI 43-101 compliant resources      | 59 Mt @ 0.68 % $V_2O_5$ , graphite content not known                                                                                                                                                              |
| Share of global vanadium resources | 0.63 % ( <i>USGS estimate global vanadium resources of 63 Mt</i> )                                                                                                                                                |
| Waste to ore ratio (whole orebody) | Expected to be relatively low due to near-surface mining                                                                                                                                                          |
| Annual production                  | Not defined yet                                                                                                                                                                                                   |
| Life of mine                       | Not defined yet                                                                                                                                                                                                   |
| Investment required                | No public information on CAPEX for exploration or mine construction                                                                                                                                               |
| Net present value (NPV)            | Insufficient economic data                                                                                                                                                                                        |
| Value addition potential           | There is potential for downstream processes, including vanadium upgrading and $V_2O_5$ production. The company plans the construction of several graphite battery anode plants in Asia, North America and Europe. |

#### Mining and processing:

- NextSource currently provides no information on the mining and processing of the Green Giant ore. Due to the near-surface location and the hard rock deposit, conventional open pit mining methods with drilling and blasting and subsequent loading and haulage with a low strip ratio can be assumed. This method is used by NextSource in the neighbouring Molo Graphite Project.
- The current estimated cut-off grade suggests that the process plant would be required to treat an average grade of <1 %  $V_2O_5$ . Gravity separation and flotation were considered in the metallurgical test work to remove graphite and sulphides from the silicates and oxides that contain most of the vanadium; however, both graphite and sulphide concentrates would contain significant vanadium contents of up to 20 %. This would require separate process routes for the resultant three products (sulphide, graphite, and mica/clay/quartz). Leaching of a silicate

composite sample was tested using sodium carbonate (soda ash) in a pressure leach process after an oxidising pre-roast at 1,100 °C showing vanadium recoveries of up to 82 %.

- The flowsheet of graphite ore processing at the neighbouring Molo Graphite Project to produce flake graphite of 96-98 % carbon purity could be adopted for the Green Giant project. The Company plans to build several battery anode facilities in Asia, North America and Europe, which will include the spheroidisation and purification processes to produce spheroidal purified graphite (99.995 % carbon) and finally coating of the spheroidal purified graphite.

### **BGR assessment and comments:**

- The deposit is a medium-grade, high-tonnage vanadium project. The relatively shallow position of the mineralisation should allow a low waste to ore ratio. The current resource estimate does not consider graphite.
- The company-owned neighbouring Molo graphite project is already in production. A reconnaissance program by the company focused on delineating graphite trends associated with vanadium mineralisation. Several shallow graphitic trends were identified that visually indicated both a higher carbon content and larger flake size than those associated with vanadium mineralisation. These trends actually hold potential for resource upgrades of the Molo project and make a development of the Green giant project less probable at present.
- However, due to the close proximity of both project sites the Green Giant project may benefit from infrastructure development at the Molo site, as several facilities (e.g. transport infrastructure, processing, power supply, staff facilities etc.) may also be used for later operation at Green Giant.
- The Green Giant Project is located at the village of Fotadrevo, ~145 km southeast of the city and port of Toliara and 13 km west of the company-owned Molo graphite project site. Green Giant is accessed from Toliara via a 70 km paved road to the village of Andranovory and to the village of Fotadrevo via 268 km of dirt roads which may seasonally be impassable. It is assumed that retrofitting will be necessary to optimise road transport. Due to its remote location, the company supplies the Molo project with diesel and solar power. The power supply would need to be upgraded to meet Green Giant's electricity demand. The water supply can be provided by collecting storm and rainwater.

### **3.5.3 ESG assessment**

Due to the early stage of the project information in several ESG categories are not yet available. However, NextSource is also operating the Molo graphite project, which is located about 9 km east of the Green Giant project and already in production stage. For ESG categories in which a

comparison appeared reasonable (in particular management practices and track records) information from the Molo project were used for this assessment.

Overall, no major ESG issues which would pose a risk that could not be handled by diligent management and operational practice were identified at this stage of the project. There is no general indication of a lack of good practice at the Molo project for ESG issues also relevant for the Green Giant project. However, leaching technology is specific for the Green Giant project and therefore not comparable.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Environmental management                                           | Environmental management system established at the Molo project with three focal areas: water, dust and biodiversity. Two environmental incidents occurred in 2023 at the Molo site: an uncontrolled release of process water onto plant grounds with seepage to neighbouring land as well as an uncontrolled release of sewage from equipment malfunction. Both incidents resulted in the establishment of additional containment infrastructure to prevent any release into the environment from a recurrence.                       |
| Efficient use of energy, renewable energy, GHG emissions reporting | Due to remote site location no grid electricity will be available and on-site diesel generators will be required for power generation. At the Molo site a solar battery hybrid power plant is operational generating 35 % of the power requirements. NextSource is committed to maintain minimum 30 % renewable share for overall energy consumption; combination of supply for both project sites might be a feasible option.                                                                                                         |
| Water management and consumption                                   | Semi-arid area with overall low water stress; rainy season from December to March, dry season April to November, precipitation 300 to 500 mm in the area; extreme weather events during rainy season may cause stormwater events, adequate water management needed; high riverine flood risk. NextSource supports maintenance of wells and boreholes for community water supply.                                                                                                                                                       |
| Pollution prevention                                               | AMD potential at the Molo project is seen as low in the short-term but potentially higher in the long-term, specifically relevant for post-closure; no detailed information on AMD potential specific for the Green Giant project but assumed to be comparable, flotation test work includes separation of sulphides enabling separated disposal. Flotation technology may imply use of hazardous reagents, in case of graphite flotation usually fuel oil or kerosene are applied. Leaching technology imply use of acids or cyanide. |
| Air quality                                                        | Required mitigation measures depend on distance to settlements; final location and size of operation not defined at this project stage. Wind barriers and actively monitored and controlled sprinkler system are installed at Molo project site.                                                                                                                                                                                                                                                                                       |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Tailings management                                       | NextSource works towards alignment with ICMM Global Industry Standards on Tailings Management; no specific information on TSF for the Green Giant project at this stage.                                                                                                                                                                                                         |
| Waste management                                          | No information available on waste management policy. The company's ESG report for 2023 states a commitment to ensure disclosure in 2024.                                                                                                                                                                                                                                         |
| Hazardous materials management                            | Flotation, leaching and use of required reagents is considered low risk assuming responsible handling; no specific information on used reagents available. Flotation technology is applied by NextSource at the Molo project, track record indicating general good operational practice; leaching technology is specific for Green Giant, therefore no evidence of practice yet. |
| Noise and vibration                                       | Required mitigation measures dependable on distance to settlements; final location and size of operation not defined at this project stage. NextSource practices legislative required pre- and post-blast communication at the Molo project site.                                                                                                                                |
| Protected areas and biodiversity                          | The project is not located in or close to any key biodiversity areas or other designated protected areas. Project area impacted by agricultural activities, herding in particular; local fauna under pressure of hunting.                                                                                                                                                        |
| Mine closure                                              | No specific information on mine closure available for the Green Giant project at this stage; the mine closure approach planned for the Molo project appears reasonable.                                                                                                                                                                                                          |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                  |
| Community health, safety and security                     | The village of Fotadrevo (around 35,000 inhabitants) lies in the southwest edge of exploration area, some further smaller settlements are located in the exploration area; impact on communities depends on the final location and size of operation which is not clear at this stage.                                                                                           |
| Dialogue and engagement with communities and stakeholders | NextSource states active dialogue with local stakeholders and an established grievance mechanism; 31 grievances had been raised and resolved for the Molo project.                                                                                                                                                                                                               |
| Land acquisition and involuntary resettlement             | Extension of mining operation not defined at this project stage; resettlement might be necessary, but no definitive information available.                                                                                                                                                                                                                                       |
| Occupational health & safety management                   | Focus on risk minimisation as well as safety and competency training as part of implementing a company-wide OHS management system based on ISO 45001; working towards formal certification. No information specific for Green Giant available.                                                                                                                                   |
| Workers' rights                                           | Madagascar scores 65/100 in the Labour Rights Index. No indication of any shortcomings found on side of NextSource.                                                                                                                                                                                                                                                              |
| Gender and diversity                                      | Percentage of female employees: 10 %. Percentage of female employees in management (top and senior): 14 %.                                                                                                                                                                                                                                                                       |
| Local value added and community development               | NextSource is committed to limit expatriate share of the workforce; internship program for job qualification in place. CSR measures in the region comprise funding of road repairs, sport facilities, educational infrastructure, agricultural training. Procurement strategy involving local                                                                                    |

| ESG category               | Assessment                                                                                                                                                                                                                                                                               |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | and regional suppliers, NextSource states complete reliance on local suppliers would lead to inflation of food prices; NextSource is committed to supports its suppliers in development and diversifying their business.                                                                 |
| <b>Governance</b>          |                                                                                                                                                                                                                                                                                          |
| Legal compliance           | Relevant policies in place. No indication of any breaches of law found.                                                                                                                                                                                                                  |
| Management practices       | Comprehensive and structured information on ESG policies and management. Working towards ISO 45001 certification.                                                                                                                                                                        |
| Transparency and reporting | Listed on the Toronto Stock Exchange; extensive information for investors and reports on financial accounts and shareholder structure available. Annual ESG reporting with reference to the GRI Standards and in alignment with other relevant formats including the ICMM, IFC and TCFD. |
| Business ethics            | Madagascar scores 25/100 in the Corruption Perception Index; Madagascar is an EITI country. No indication of unethical company practices found. Anti-bribery and Corruption, Whistleblower, and Human Rights policies in place.                                                          |

Table 9. ESG features of Green Giant project, Madagascar

### 3.5.4 Further reading

Energizer Resources Inc. (2011): Green Giant Project - Fotadrevo, Province of Toliara, Madagascar. Technical Report Update NI 43-101. [https://www.nextsourcematerials.com/wp-content/uploads/2023/11/Green\\_Giant\\_Vanadium\\_NI\\_43-101\\_report\\_2011-01-14-1.pdf](https://www.nextsourcematerials.com/wp-content/uploads/2023/11/Green_Giant_Vanadium_NI_43-101_report_2011-01-14-1.pdf) (accessed: 22.01.2024)

NextSource Inc. (2022): Molo Phase 2 Preliminary Economic Assessment. National Instrument 43-101 Technical Report. [https://www.nextsourcematerials.com/wp-content/uploads/2023/11/NEX3001\\_Molo-Phase-2-Preliminary-Economic-Assessment.pdf](https://www.nextsourcematerials.com/wp-content/uploads/2023/11/NEX3001_Molo-Phase-2-Preliminary-Economic-Assessment.pdf) (accessed: 22.01.2024)

NextSource Materials (2023): ESG Report 2023. <https://www.nextsourcematerials.com/wp-content/uploads/2023/12/NSM-2023-ESG-Report-Final.pdf> (accessed: 28.01.2024)



### 3.6 Kabanga Ni (-Co-Cu) massive sulphide project (Tanzania)

Information as of 09/2023

#### 3.6.1 General project background

|                                    |                                                                                                                                                                                                                                       |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Nickel                                                                                                                                                                                                                                |
| <b>Other commodities</b>           | Cobalt, copper; gypsum (potentially as backfill material)                                                                                                                                                                             |
| <b>Location</b>                    | Kagera, Tanzania<br>02°53' S and 30°34' E, 1,400 – 1,600 m.a.s.l.                                                                                                                                                                     |
| <b>License type</b>                | Special Mining License 651/2021 (valid until 10/2054)                                                                                                                                                                                 |
| <b>License owner / operator</b>    | Tembo Nickel Corp. (JV: 84 % Kabanga Nickel Ltd., 16 % Gov. of Tanzania 16 %), Kabanga Nickel is currently under control of Lifezone Metals (83 %) and BHP (17 %)                                                                     |
| <b>Contact</b>                     | Lifezone Metals Ltd., Commerce House 1,<br>Bowring Road, Ramsey IM8 2TF, United Kingdom<br><a href="http://www.lifezonemetals.com">www.lifezonemetals.com</a><br><a href="mailto:info@lifezonemetals.com">info@lifezonemetals.com</a> |
| <b>Project status</b>              | Scoping & Pre-Feasibility                                                                                                                                                                                                             |
| <b>Possible production by 2030</b> | Announced for 2025, depending on feasibility study                                                                                                                                                                                    |



Figure 6. Kabanga project location, Tanzania

### 3.6.2 Economic assessment

#### General project background:

Kabanga is believed to be one of the world's largest and highest-grade nickel sulphide deposits. Exploration at Kabanga has been undertaken in a number of different phases for over 45 years, with more than 598 km drilled (as of 12/2022). The project is located within the north-east trending East African Nickel Belt, which extends from Zambia in the south-west, for 1,500 km through the DR Congo, Burundi, Rwanda, Tanzania and Uganda in the north-east, and straddles the western boundary of the Tanzania Craton to the east and the eastern boundary of the Congo Kasai Craton to the West. The nickel-bearing massive sulphide mineralisation is hosted by mafic to ultramafic intrusions, namely the North, Tembo, Main and MNB, which are found within north north-east striking, steeply westward dipping and overturned metasediments. A resource definition drill program is underway and ongoing at North and Tembo to support the definitive feasibility study mine plan and reserve statement. The current exploration activity is backed and funded by BHP. Lifezone went public through SPAC merger in 2023, believing the public listing might also improve its position for negotiating offtake sales with OEMs for Lifezone's potentially "greener" nickel; it intends to attract strategic investors through the closing process to minimize potential funding gaps. The final Kabanga investment decision is expected in late 2023 or early 2024. The owner seeks investment for a resource definition drill program at North and Tembo, which is expected to be completed in Q3 2024 to support the definitive feasibility study, mine plan and reserve statement.

#### Project description:

|                                    |                                                                                                                                                                                       |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Ni(-Cu-Co)-bearing layered mafic-ultramafic intrusions                                                                                                                                |
| NYSE-SEC compliant resources       | 40.4 Mt @ 2.61 % Ni, 0.35% Cu and 0.19 % Co                                                                                                                                           |
| Share of global nickel resources   | 0.3 % ( <i>USGS estimate global Ni resources of 300 Mt</i> )                                                                                                                          |
| Waste to ore ratio (whole orebody) | Unknown, but expected low because of underground mining and selective method with backfill planned                                                                                    |
| Annual production                  | First ore in 2026; 2.2 Mt of ore during ramp-up phase referring to 50,000 t of contained Ni, 6,000 t of contained Cu and 3,700 t of contained Co; 3.5 Mt ore throughput after ramp-up |
| Life of mine                       | 15-18 years                                                                                                                                                                           |
| Investment required                | CAPEX for mine construction not yet defined due to early stage of project                                                                                                             |
| Net present value (NPV)            | To be defined in feasibility study                                                                                                                                                    |
| Share of global nickel production  | 1.5 % (2.2 Mt of ore/a, recovery 88 %)<br>( <i>USGS estimate global Ni production of 3.3 Mt in 2021</i> )                                                                             |
| Share of global cobalt production  | 1.9 % (2.2 Mt of ore/a, recovery 90 %)<br>( <i>USGS estimate global Co production of 190,000 t in 2022</i> )                                                                          |
| Value addition potential           | Refining shall take place in Tanzania at the Kahama refinery that would be built by Tembo Nickel JV and provides for vertical upstream integration of the operations.                 |



**Mining and processing:**

- Mine access by parallel ramps (in the first phase ~300 m deep), conventional underground mining methods employing drilling by drill jumbos, blasting, loading and level hauling by LHD (load-haul-dump) units. A fleet of trucks would realize the ramp haulage. As ground support, backfill of mined out stopes would be used. The backfill material would come from borrow pits; tailings from the own processing plant can be used, too.
- The value elements are associated with the sulphide mineral pentlandite. The pentlandite in the ore is concentrated via crushing, milling and selective flotation into a pentlandite concentrate. The tailings from the rougher and cleaner flotation still contain sulphide minerals like the reactive pyrrhotite. Before the tailings can be used as backfill material, the pyrrhotite has to be separated and deposited in tailings disposal facility. (The information about mining and mineral processing is derived from former documents of the Kabanga Nickel Company Ltd. in 2010). The assumed recoveries after processing refer to 87.2 % and 88.1 % for Ni and Co, respectively.
- The nickel concentrate would be transported via road trucks or possibly by train to the planned refinery at Kahama. The transport distance is about 340 km and the transport volume of concentrates about 244,000 t/a.
- At the Kahama refinery, the concentrates shall be leached by pressure oxidation using a customised process that is patented by the company Lifezone Metals based in UK, which is the main owner of Kabanga Nickel, which is the holding company of the Tembo Nickel JV. The final products are class I nickel, cathode copper and cobalt. The refined end products are transported via railway over a distance of 970 km to the port of Dar Es Salaam from where the products loaded onto vessels (about 40,000-60,000 t/a).
- The C1 cash costs for nickel production in 2030 are estimated at US\$ 2.500/t. This places Kabanga as a low cash cost producer in the first quartile of the cash cost curve.

**BGR assessment and comments:**

- The Kabanga deposit would be a high-grade, medium-tonnage underground operation, comparable in size and mineralogy to the nickel assets of Vale and Glencore (e.g., the Creighton Mine and Coleman Mine) in Sudbury, Canada. Because of the selective mining methods using backfill, the expected waste to ore ratio would be low. The relatively long life of mine (15 - 18 years) can be positive for the development of the region. Resource expansions are possible due to the possible vertical extension of the deposit.
- The relative shallow mineralisation supports early production and cash flow. The calculated high nickel equivalent grade of the ore (3.3% Ni<sub>eq</sub>), the expected low cash and capital

costs and the positive outlook for the nickel market in the long-term may support the economic feasibility of the Kabanga project.

### 3.6.3 ESG assessment

The level of publicly available project information is limited because of the early project stage. Environmental planning and resettlement action plan for the mining project will be completed in 2023 and for the refinery, the environmental planning will be completed in 2024, according to Lifezone Metals. No major ESG issues were identified that would preclude responsible investment. The owner of the project, Lifezone Metals, comprehensively documents its corporate policies and management systems. Environmental risks are generally considered to be low, although water management in the arid environment may be challenging. Stakeholder engagement and OHS management is widely in place, as are CSR measures. According to the former project owner, Kabanga Nickel, about 300 households could be affected. Participation in the resettlement and a compensation plan had been considered in 2010. Since 2022, a resettlement action plan, including a livelihood restoration plan, to support the communities surrounding and community consultation is in development. Tembo Nickel will need to acquire surface use rights for up to 4,300 ha of land in order to develop Kabanga.

The pressure oxidation process would result in a significantly reduced carbon footprint compared to the classical pyrometallurgical process route for nickel concentrates. An expected advantage with respect to the climate relevance of the Kabanga project is the possible use of hydropower that would come from Rusumo Hydroelectric Project, planned to generate ~80 MW to be shared between Rwanda, Burundi and Tanzania.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Environmental Management                                           | Aim to set environmental goals and targets and respective management. An EIA certificate (EC/EIS/824) for the mine was granted in 2013 based on the EIA process, and report completed in 2013. The certificate, originally granted to Kabanga Nickel Comp. Ltd, was transferred to Tembo Nickel Comp. Ltd on 16 June 2021.                                                                                                                                                                                                                                                                                                                            |
| Efficient use of energy, renewable energy, GHG emissions reporting | At the mine start electrical power is produced by diesel generators. A change to grid is planned to be supplied by the Rusumo hydropower project that is under planning. The hydrometallurgical process at the Kahama refinery is expected to have lower CO <sub>2</sub> eq. emissions, and electricity used compared to the classical pyrometallurgical process route. Company reviewing opportunities to reduce carbon in mining processes. The forecasted CO <sub>2</sub> -intensity of only 4-5 t of CO <sub>2</sub> eq./t Ni <sub>eq.</sub> will place Kabanga in the lowest quartile of the nickel industry's CO <sub>2</sub> -intensity curve. |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Water management and consumption                          | Water supply from mine dewatering and recycling. In later years a pipeline from Rubuvu river (15 km) will be constructed; potable and make-up water from boreholes. A water balance will be part of the DFS and the final EIS. Specific water management measures are required to limit potential water quality impacts from the mine, waste dumps and tailings during operation and after closure. Low water stress; high riverine flood risk. |
| Pollution prevention                                      | Acid mine drainage risk is indicated by the high sulphur contents of ore and waste rock. Management by the use of desulphurised tailings and special tailings pond facility for highly reactive pyrrhotite.                                                                                                                                                                                                                                     |
| Air quality                                               | Scarcely populated area, OHS management will be in place, considered low risk.                                                                                                                                                                                                                                                                                                                                                                  |
| Tailings management                                       | Desulphurised tailings will be used as backfill. In the upper part of the deposit cemented backfill will be used, in later mining stages paste backfill. Special disposal facility for pyrrhotite containing tailings that is lined and contains seepage.                                                                                                                                                                                       |
| Waste management                                          | Waste rock dump (lined).                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Hazardous materials management                            | Beneficiation process using flotation, considered low risk. Reactives used (indicative consumption): CaO (4kg/t), PEX (180 g/t), promoter (125 g/t), depressant (300 g/t), frother (15 g/t), anionic flocculant                                                                                                                                                                                                                                 |
| Noise and vibration                                       | OHS management will be in place, scarcely populated area, considered low risk.                                                                                                                                                                                                                                                                                                                                                                  |
| Protected areas and biodiversity                          | The project is not located in or close to a key biodiversity area. Currently agricultural land use. Expected biodiversity impacts are low.                                                                                                                                                                                                                                                                                                      |
| Mine closure                                              | A closure concept has been prepared during the EIA process in 2013. Cost breakdown has been prepared that includes severance payments and other social costs linked to social transitioning post closure, updating is envisaged; regulation requires rehabilitation bond.                                                                                                                                                                       |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Community health, safety and security                     | Scarcely populated area; in general, impacts on local communities are considered low risk (after resettlement measures). Security will be managed collaboratively and in partnership with communities and local government, and via training on the Voluntary Principles on Security and Human Rights.                                                                                                                                          |
| Dialogue and engagement with communities and stakeholders | Company states to have structured and continuous dialogue with local communities in place as well as CSR measures; Community engagement and CSR focused on health, safety, environment and education. Tembo Nickel carries out activities like education programs in the community and upskilling the future workforce and creating jobs.                                                                                                       |
| Land acquisition and involuntary resettlement             | Relocation and Resettlement Action Plan (RRAP) was prepared in and consulted 2013 by Kabanga Nickel Comp. Tembo Nickel engaged an independent consultants to undertake a new RRAP in 2022. 300 households are considered for resettlement; related surveys (socio-economic, livelihood etc.) are underway.                                                                                                                                      |

| ESG category                                | Assessment                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Occupational health & safety management     | Professional management and OHS measures are not yet elaborated because of the early project stage. However, the project is expected to be in line with international OHS standards, according to the project owners.                                                                                                                                                                              |
| Workers' rights                             | Regulations are not yet elaborated because of the early project stage. However, the project is expected to be in line with international standards, according to the project owners.                                                                                                                                                                                                               |
| Gender and diversity                        | Regulations are not yet elaborated because of the early project stage. However, the project will abide by international standards, according to the project owners.                                                                                                                                                                                                                                |
| Local value added and community development | In-country beneficiation, job creation and community development policies and programmes in place; Focus on local content via Tanzanian management, Kabanga aims to have a labour force with a low expat representation, focus on skills transfer and training                                                                                                                                     |
| <b>Governance</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                    |
| Legal compliance                            | Relevant environmental licences are available. No indication of any breaches of law found. The government of Tanzania owns via a company vehicle 16 % of the project.                                                                                                                                                                                                                              |
| Management practices                        | Goals: Committed to good governance, operating an ethical business, promoting a culture of compliance, and integrating sustainability across all operations. Code of conduct and business ethics, whistle blower policy available, company states alignment the World Bank's Climate Smart Mining standards and relevant elements of the International Council for Metals and Mining's guidelines. |
| Transparency and reporting                  | Lifzone Metals is listed on the NYSE market, though SPAC rather than IPO; extensive information for investors, reports on financial accounts and shareholder structure available; SASB, GRI, ESRS, TCFD and TNFD are key standards and frameworks.                                                                                                                                                 |
| Business ethics                             | Tanzania ranks 87 /180 in the Corruption Perception Index of 2022; Tanzania is an EITI country; no indication of unethical practices of the company or the owners found; Financial accounts of project owner Lifzone Metals according to stock listing requirements;                                                                                                                               |

Table 10. ESG features of the Kabanga project, Tanzania

### 3.6.4 Infrastructure assessment

#### Potential Investment Needs:

- Road Infrastructure: Investment opportunity to construct reliable roadways between the project site and the refinery in Kahama.
- Railway Enhancements: US\$ 1.8bn gap for Dar es Salaam – Isaka railway upgrade. Investment opportunities to support upgrade and construction of the 400 km Isaka-Kigali standard gauge railway (estimated US\$ 1.3bn).

- **Renewable Energy Ventures:** Investment opportunity to link power infrastructure from the Rusumo Falls hydroelectric plant (predominant renewable energy source) with the project site or to develop alternative renewable energy sources, e.g. solar or wind.
- **Water Supply:** Investments required for the construction of water pipeline infrastructure to project site.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | The Kabanga nickel project hosts one of the world's largest development-ready nickel sulphide deposits. The project is located in the Ngara district in north-west Tanzania, 44 km south of the town of Ngara, south-east of the nearest town of Bugarama, and close to the border with Burundi. Mining operations would take place in Ngara, while the final metals would be refined in Kahama. The Kahama refinery would be situated at the site of the now closed Buzwagi gold mine, which ceased operations in 2021. This means that infrastructure that previously served the mine, specifically power, water, roads, and rail, would be able to be leveraged off. Furthermore, the Tanzanian government is in the process of declaring Kahama as a special economic zone, which will provide considerable tax benefits for the site.                                                                                                                                                                                                                                                                                                                                                 |
| Transport                 | The proposed mine site is accessible by road connecting to the National Route B3 at Muzani. Three potential access routes have been identified: northern, central, and southern, with the southern route currently preferred due to its shorter distance (approximately 80 km to Muzani) and being considered to have the lowest environmental and social impact. The southern route is presently a dirt road, prone, in at least two places, to rutting in the rainy season and occasional flooding. Mined and processed material can be transported via the southern route to Muzani, from where the B3 National Route leads to Kahama. This forms part of the Central Development Corridor Highway connecting the port of Dar es Salaam to Burundi, Rwanda, Uganda, and the Eastern part of the Democratic Republic of the Congo through central and northwestern Tanzania. It is part of the backbone of the regional transportation system in East and Eastern Central Africa transporting large proportion of imports and exports.                                                                                                                                                   |
| Airport                   | Ngara Airport is situated approximately 92 km from the project site by road, making it the most accessible in the region. The airport consists of a 1.65 km unpaved runway. Kahama Airport is located 320 km from the project site and is accessible by road via the southern route to Muzani and the B3 highway to Kahama. Furthermore, the airport provides nearby access to the planned hydrometallurgical refinery in Kahama, allowing imports and exports of processing materials and market products, respectively, to be streamlined. The airport consists of a 1.29 km sealed runway. Barrick Gold previously owned the airstrip as part of the Buzwagi Gold Mine infrastructure, and recently handed over a new Kahama airport terminal to the Tanzania Airport Authority worth US\$ 384,000. Commercial flights to Dar es Salaam are currently available by Precision Air. Following a site visit by the Tanzania Civil Aviation Authority, an aerodrome study has confirmed that the proposed area at the Kabanga site and presented design is suitable for an 80-seater aircraft. Construction of the aerodrome and supporting infrastructure was planned to commence in 2023. |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rail access  | There is a railway from Dar es Salaam to Isaka (1,223 km) that is currently being upgraded. This segment, however, requires a further US\$ 1.8bn of funding for the completion of Lots 3 and 4. Isaka is approximately 350 km south-east of the project (approximately 90 km south-south-east of Bulyanhulu). Moreover, the Kahama refinery is located approximately 40 km west of Isaka, where considerations should be made into establishing a direct rail link to improve transport efficiencies. The government of Tanzania has announced plans to invite international tenders for the construction of the 400 km Isaka-Kigali standard gauge railway that starts from Isaka dry port to neighbouring country of Rwanda. As of July 2023, it was estimated that the construction project would cost US\$ 1.3bn. The entire project, including the upgrade of the segment between Dar es Salaam and Isaka, and the construction of the new railway between Isaka and Kigali, was estimated to cost US\$ 2.5bn. This railway would drastically improve transport logistics, with the planned station in Keza (Tanzania) situated approximately 53 km north (via road) of the Project.                                                                                                                                                                                                  |
| Port         | The port of Dar es Salaam is located approximately 1,600 km by road from the Kabanga Nickel Project and will be the primary port for exports to international markets outside of Africa. Refined material can currently be transported from Kahama to the port via the B3, B141, B129, and A7 National Routes, or via the Isaka-Dar es Salaam railway. Dar es Salaam port is Tanzania's principal port with a rated capacity of 14.1 million t dry cargo and 6.0 million t bulk liquid cargo. The port has a total quay length of about 2,600 m with eleven deep-water berths. Dar es Salaam port handles about 95 % of the Tanzania international trade. The Tanzanian Ports Authority recently signed a 30-year concession agreement with Dubai's logistics multinational DP World to upgrade the Port of Dar es Salaam. This includes an initial investment of US\$ 250m during the first phase, and an overall projection of US\$ 1bn. This will go towards "cutting-edge technologies and advanced equipment", to boost the port's annual cargo handling capacity from its current 750,000 TEU. Initially, the investment will focus on improving cargo-clearing systems and eliminating delays, but potential future investments include temperature-controlled storage to enhance Tanzania's agricultural sector, as well as improved connections to hinterland rail freight links. |
| Energy       | Infrastructure in the Ngara district is limited in terms of national grid power. A transmission line and sub-station from a new hydroelectric project to the north-west of Tanzania is within 70 km of the project site and an extension of the 200 kV line to the project is planned within the development time of the project. Once completed, the Rusumo Falls Hydroelectric Project will generate approximately 80 MW to be shared between Rwanda, Burundi, and Tanzania. Power is currently supplied by diesel generators located on-site. Power infrastructure is readily available at the Kahama refinery from historical works at the Buzwagi gold mine (Barrick Gold). Alternative renewable energy sources (e.g., solar, wind) in the region need to be assessed case-by-case. The geography in the project area does not pose any limitations to the installation of alternative renewable energies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| GHG emission | Lifezone's refining approach adopts hydrometallurgical processing technology and produces far less harmful carbon and sulphur dioxide than its smelting equivalent (up to 73 % less CO <sub>2</sub> equivalent and zero SO <sub>2</sub> emissions). The hydrometallurgical process is expected to reduce the carbon footprint, minimise environmental impact, lower capital and production costs. Refining locally furthermore removes the need to ship ore concentrates overseas for beneficiation, resulting in an estimated 25,000 km less                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

|       |                                                                                                                                                                                                                                                                                                                                                                                        |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       | transportation (to North America and Europe). Efforts to link power infrastructure from the Rusumo Falls hydroelectric plant with the project site should be prioritised to ensure clean and stable power supply for the life of the mine.                                                                                                                                             |
| Water | Infrastructure in the Ngara district is limited in terms of reticulated potable water supplies. Site water is currently provided by a borehole located 900 m to the north-west of the camp, near the summit of the hill. At later stages, water is planned to be sourced via pipeline from the Ruvubu river (15 km). Existing water infrastructure at the Kahama refinery can be used. |

**Table 11. Infrastructure assessment of Kabanga project, Tanzania**

### 3.6.5 Further reading

Kabanga Nickel Project, Presentation to Ausmine 2010 (2010):

<https://www.yumpu.com/en/document/read/52069602/kabanga-nickel-project-austmine>

(accessed 08.09.23)

Lifeline Holdings Ltd (2023): Kabanga 2023 Mineral Resource – Final Draft.

<https://www.sec.gov/Archives>

[/edgar/data/1852940/000121390023014389/ea174213ex96-1\\_gogreen.htm](https://www.sec.gov/Archives/edgar/data/1852940/000121390023014389/ea174213ex96-1_gogreen.htm) (accessed 20.03.24)

Lifeline Metals (2023): Investor Presentation July 2023.

[https://s201.q4cdn.com/375092174/files/doc\\_presentation/2023/07/Lifeline-Metals-Investor-Presentation-July-2023.pdf](https://s201.q4cdn.com/375092174/files/doc_presentation/2023/07/Lifeline-Metals-Investor-Presentation-July-2023.pdf)

(accessed 19.03.24)

Lifeline Metals (2023): Investor Presentation September 2023.

[https://s201.q4cdn.com/375092174/files/doc\\_presentation/2023/08/Lifeline-Metals-Investor-Presentation-September-2023.pdf](https://s201.q4cdn.com/375092174/files/doc_presentation/2023/08/Lifeline-Metals-Investor-Presentation-September-2023.pdf) (accessed 08.09.23)

Lifeline Metals (2023): KABANGA 2023 MINERAL RESOURCE TECHNICAL REPORT SUMMARY, EFFECTIVE AT FEBRUARY 15, 2023, in accordance with the U.S. Securities and Exchange Commission (US SEC) Regulation S-K subpart 1300 rules for Property Disclosures for Mining Registrants (S-K 1300).

[https://www.sec.gov/Archives/edgar/data/1852940/000121390023014389/ea174213ex96-1\\_gogreen.htm](https://www.sec.gov/Archives/edgar/data/1852940/000121390023014389/ea174213ex96-1_gogreen.htm) (accessed 08.09.23)

Ore Win (2023): Lifeline Metals Ltd – Kabanga 2023: Mineral Resource Update, Technical Report Summary.

[https://s201.q4cdn.com/375092174/files/doc\\_downloads/2023/12/22016KabangaMinResTRS\\_231207Rev0.pdf](https://s201.q4cdn.com/375092174/files/doc_downloads/2023/12/22016KabangaMinResTRS_231207Rev0.pdf) (accessed 18.03.24)

NS Energy (2024): Lifeline Metals plans two-phase development for Kabanga nickel project.

<https://www.nsenergybusiness.com/news/lifeline-metals-plans-two-phase-development-for-kabanga-nickel-project/> (accessed 18.03.24)



### 3.7 Kangankunde REE carbonatite project (Malawi)

Information as of 04/2024

#### 3.7.1 General project background

|                                    |                                                                                                                                                                                                                                                                  |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Light REE (Ce, La, Nd, Pr)                                                                                                                                                                                                                                       |
| <b>Other commodities</b>           | Strontium                                                                                                                                                                                                                                                        |
| <b>Location</b>                    | Balaka, Malawi<br>15°7' S, 34°54' E, 650 – 800 m.a.s.l.                                                                                                                                                                                                          |
| <b>License type</b>                | Exploration Licence EPL0514/18R and Mining Licence MML0290/22                                                                                                                                                                                                    |
| <b>License owner / operator</b>    | Lindian Resources Ltd. (75 %, with an agreement to acquire the remaining 25 % from shareholders of previous owner)                                                                                                                                               |
| <b>Contact</b>                     | 108 St Georges Terrace, Perth WA 6000 Australia<br>Direct contact established: No<br><a href="https://www.lindianresources.com.au/">https://www.lindianresources.com.au/</a><br><a href="mailto:admin@lindianresources.com.au">admin@lindianresources.com.au</a> |
| <b>Project status</b>              | Feasibility study to be completed in Q2/2024                                                                                                                                                                                                                     |
| <b>Possible production by 2030</b> | Possible, but unlikely                                                                                                                                                                                                                                           |

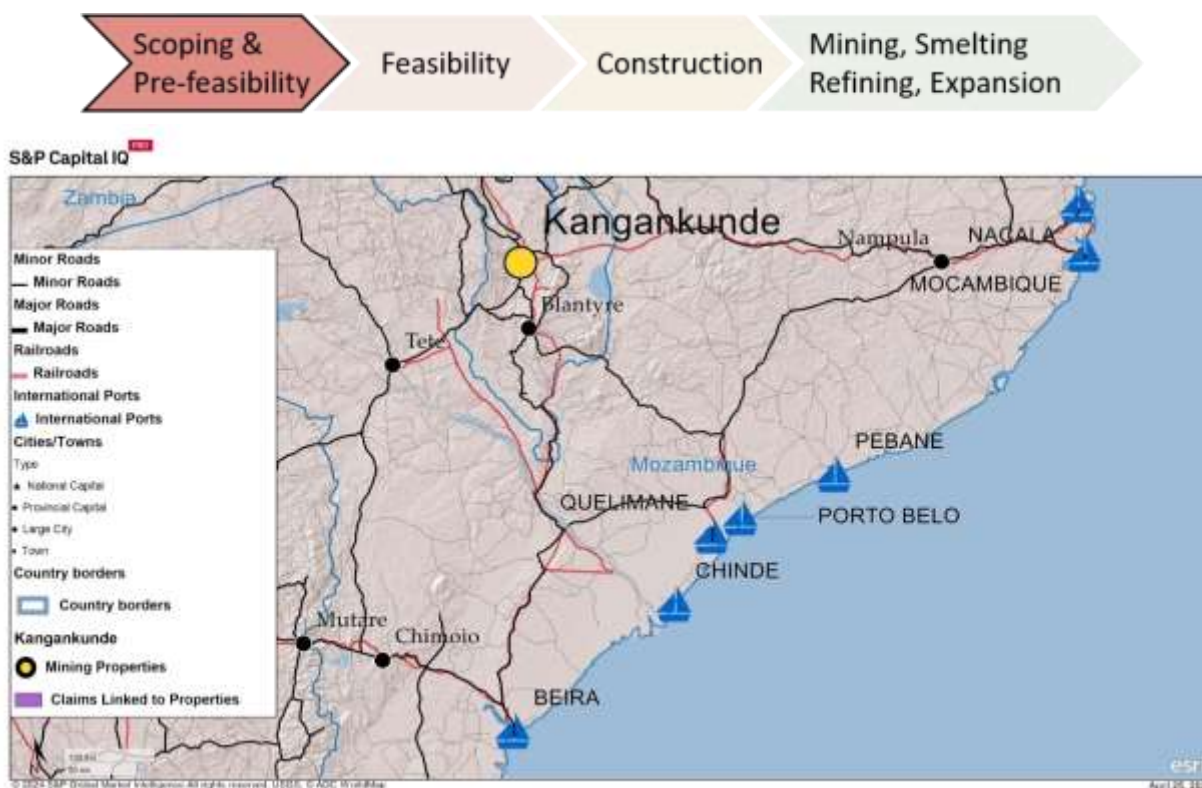


Figure 7. Kangankunde project location, Malawi



### 3.7.2 Economic assessment

#### General project background:

Kangankunde is located 90 km north of the city of Blantyre, the main economic and commercial centre in Malawi. The town of Balaka, 15 km to the north of Kangankunde, has a population of about 36,000 people. The deposit is a carbonatite with varying contents of iron oxide, manganese oxide and pink-coloured potassium alteration. It contains brecciated rocks related to wall fracturing during the intrusive formation including mixed breccias of carbonatite and the wall rock, often altered gneiss. The main rare earth mineral at Kangankunde is monazite, which occurs as clasts and matrix in the carbonatite.

Historical exploration programmes were carried out at Kangankunde already in 1954 and were continued by the French Geological Survey BRGM in the 1980s. During this time, BRGM has built up an extensive exploration database incl. process test work. In 2007, the Australian based rare earth miner Lynas Corp. acquired the project and continued exploration work. However, due to a long-lasting rights dispute with the former owner Rift Valley Resources, the project was put on hold. In 2019, Lindian Resources acquired the exploration rights from Rift Valley Resources after the Malawi Supreme Court ruled in favour of the previous rights holder and taking over the development of Kangankunde in August 2022. Since then, three drilling programs have been completed resulting in an updated mineral resource estimate to be released in April 2024 and a Feasibility study scheduled for Q2 2024 (results are therefore not included in this assessment).

#### Project description:

|                                                           |                                                                                                              |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Ore deposit type                                          | Carbonatite                                                                                                  |
| JORC compliant resources (2012)                           | 261 Mt @2.19 % TREO                                                                                          |
| Waste to ore ratio                                        | N/A                                                                                                          |
| Annual production                                         | 5,000 t REO (minimum estimate of the previous owner);<br>~13,500 t REO according to recent purchase contract |
| Share of global TREO production                           | 4.8 % ( <i>USGS estimate global TREO production of 280 kt</i> )                                              |
| Life of mine                                              | Not defined yet                                                                                              |
| Investment required                                       | CAPEX for mine construction expected to be defined in<br>feasibility study                                   |
| Net present value (NPV; nominal<br>discount rate of 10 %) | N/A                                                                                                          |

#### Mining and processing:

- For the purposes of the MRE, two lithological domains were identified in the Kangankunde deposit: a carbonatite breccia and a mixed breccia of carbonatite and the wall rock, a hornblende gneiss. Monazite is the dominant rare earth mineral of the deposit that has an extremely low natural radiation level in comparison to other rare earth deposits with an average of 11 ppm ThO<sub>2</sub> per percentage of REO content. The mineralisation is dominated by light rare

earth oxides (50.8 % Ce, 27.0 % La, 15.2 % Nd, 5.0 % Pr of TREO) while NdPr-oxides are the most valuable product.

- In the planned stage 1 processing facility, a monazite concentrate is to be produced by crushing and classifying the crushed feed material and subsequent magnetic separation, removal of impurities and filtration/drying of the product. Completed metallurgy test work shows that the concentration process of gravity separation and magnetic separation can produce a 60 to 66 % REO concentrate with a recovery rate of 70 %.
- The development plan announced the publication of a feasibility study in Q2/2024 followed by a one year construction phase resulting in commissioning and production in the second half of 2025.
- Strontium is a potential by-product, even though it is not explicitly mentioned by Lindian Resources. In 2002, a feasibility study to establish the viability of extracting strontianite ore at Kangankunde and processing it into strontium carbonate was co-financed by the European Investment Bank.

### **BGR assessment and comments:**

- The deposit is a medium-grade, high-tonnage light rare earth project with a remarkable low radiation, so that transport of the monazite concentrates should be possible without special measures for radiation management. Mineralisation is present close to the surface with an extension of 800 m N-S and 700 m E-W outcropping as a hill. Deep drilling has identified an additional exploration target of 20 Mt TREO, bearing the potential to expand the already large resource estimate.
- It is important to note that current MRE relates to inferred mineral resources only. Inferred mineral resources by definition have a low confidence level and further drilling with higher quality sampling is required (as in the current undisclosed campaign) to increase the confidence level and classify indicated mineral resources.
- Infrastructure and in particular the transport of the monazite concentrate (>20,000 tonnes/year) is the biggest challenge in a landlocked country like Malawi and investment is required to upgrade unpaved roads and connect the project site to the existing rail network. Kangankunde can be accessed via a 6 km dirt road from the national highway M1. The ports of Beira and Nacala (both in Mozambique) are more than 800 km away. There is a possible rail connection to Nacala via Blantyre-Balaka railway line (~10 km East). A high-voltage power line is 6 km away.
- The existing sales and purchase agreement with the US company Gerald Metals for 45,000 tonnes of monazite concentrate within 5 years in phase 1 (40% of total production) reduces the

availability of monazite concentrate for the open market. In addition, the further processing of the concentrate is the main bottleneck in providing a usable rare earth product for the international markets.

### 3.7.3 ESG assessment

The Exploration and Mining Licences have an Environmental and Social Impact Assessment Licence No.2:10:16 issued under the Malawi Environmental Management Act No. 19 of 2017. However, ESG data availability is very limited as a Feasibility study, including an Environmental and Social Impact Assessment (ESIA) and environmental management plan has been not available at the date of this assessment (04/2024). Furthermore, no Scoping or Pre-feasibility study is publicly available. Based on the information available, no serious ESG risks could be identified for the Kangankunde project.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Environmental management                                           | As part of the Feasibility study, an Environmental Management Plan was drawn up and an Environmental and Social Impact Assessment was carried out (no details known).                                                                                                                                                                                                                                                                                                                                      |
| Efficient use of energy, renewable energy, GHG emissions reporting | A third-party provider is commissioned with the planning and construction of a power plant. Lindian announced to measure and report Scope 1-3 GHG emissions in line with the Greenhouse Gas Protocol. 81% of electricity from the grid in Malawi is from renewables (IRENA, 2022).                                                                                                                                                                                                                         |
| Water management and consumption                                   | The project site is located in an area of sub-tropical humid climate with low water stress, however there might be stormwater related risks and a low to medium riverine flood risk. Groundwater is to be used for operations which might lead to conflicts with local communities. The envisaged water-only, low-cost gravity and magnetic beneficiation techniques are water intensive.                                                                                                                  |
| Pollution prevention                                               | The risk of acid mine drainage is low due to the neutralising effect of carbonatite in the host rocks. Contamination of groundwater by sulphates or heavy minerals is unlikely. Despite the natural Th/U content in the monazite, there is a very low radioactive signature compared to other REE deposits, however still needs respective management.                                                                                                                                                     |
| Air quality                                                        | Drill & Blast and Load & Haul mining methods as well as subsequent crushing and grinding bear the risk of dust generation, esp. during the dry season (Apr – Nov). No information on mitigation measures are available.                                                                                                                                                                                                                                                                                    |
| Tailings management                                                | In view of the large resources and the planned annual production, a large TSF is required. Lindian has announced a Tailings Governance Framework. It must be ensured that these comply with relevant local and international environmental regulations, national discharge standards and international best practice (e.g. Global Industry Standards for Tailings Management). The leaching of radionuclides into the groundwater is considered insignificant as the Th-containing monazite is to be sold. |
| Waste management                                                   | No information available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hazardous materials management                            | Thorium will remain in the Monazite concentrate that is to be sold. No chemicals are needed for the on-site processing.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Noise and vibration                                       | The most likely mining methods Drill & Blast and Load & Haul as well as the subsequent crushing and grinding have the potential to cause noise and vibrations to the neighbouring farms. The installation of systems, such as a noise buffer for the processing plant, and practices to minimise impacts on local communities have been announced. No further information available.                                                                                                                                                     |
| Protected areas and biodiversity                          | The proposed project area is characterized by forest-grassland. No protected areas are affected and biodiversity management plans have been announced to ensure there is no net loss of critical habitat.                                                                                                                                                                                                                                                                                                                                |
| Mine closure                                              | No information available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Community health, safety and security                     | The project site is located in south Malawi in a sparsely populated area. However, there are several farms and small villages in the vicinity of the site that will be directly or indirectly affected by the planned mining activities. Lindian has made several commitments in its Sustainability and Community policies, implementation cannot yet be assessed. Results of the ESIA are not known.                                                                                                                                    |
| Dialogue and engagement with communities and stakeholders | Meetings were held with local community leaders to liaise and communicate project plans and future involvement of the local community. Community and stakeholder engagement plans have been announced.                                                                                                                                                                                                                                                                                                                                   |
| Land acquisition and involuntary resettlement             | Exploration and Mining licenses are issued. No information on resettlement available. Satellite images from the envisaged mine site layout indicate that about four small houses are located within the plant area and small settlements could be affected to the east of the mine site, depending on final extension of the mine.                                                                                                                                                                                                       |
| Occupational health & safety management                   | An OHS Management System is reported to be in place, however, further information is not available.                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Workers' rights                                           | Malawi scores 68/100 in the Labour Rights Index. No indication of non-compliance with fundamental workers' rights in Lindian's activities found.                                                                                                                                                                                                                                                                                                                                                                                         |
| Gender and diversity                                      | No information available. No women in board structure (8 members).                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Local value added and community development               | ESG information on the Lindian website refers to "substantial" investments in local communities and various programmes to provide practical and collaborative support, and encouragement for further growth. However, the announced "annual updates on community development initiatives in its Annual Report" could not be found in the reports since 2019. Further commitments with regard to the economic development of host communities are made in Lindian's Community Policy, the implementation of which cannot yet be assessed. |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Legal compliance                                          | Following the ruling in the rights dispute (see above), Lindian is progressively acquiring 100% of Malawi registered Rift Valley Resource                                                                                                                                                                                                                                                                                                                                                                                                |

| ESG category               | Assessment                                                                                                                                                                                                                                                                                                                                 |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | Developments Limited (up from 75%) and its 100% ownership of Exploration Licence EPL0514/18R and Mining Licence MML0290/22 granted under the Malawi Mines and Minerals Act 2018. No evidence of legal violations found.                                                                                                                    |
| Management practices       | Lindian's Board of Directors has adopted the ASX Corporate Governance Council's Corporate Governance Principles and Recommendations 4th Edition. No indication of poor management practices.                                                                                                                                               |
| Transparency and reporting | Lindian Resources Ltd. (ASX: LIN) is listed on the Australian Securities Exchange and as such provides related information for investors. Contrary to what is announced on the homepage, the annual reports do not contain any updates on community development initiatives and safety performance. No further reporting on ESG practices. |
| Business ethics            | Malawi scores 34/100 in the Corruption Perception Index. Malawi is an EITI country. No indication of unethical company practice found. Sustainability, health and safety, environment and community policies available (one pager). Whistleblower Policy in place.                                                                         |

**Table 12. ESG features of the Kangankunde project, Malawi**

### 3.7.4 Further reading

Lindian Resources Ltd. (2024a): Kangankunde project flyer.

<https://www.lindianresources.com.au/s/Kangankunde-Project-Flyer-V5.pdf> (accessed 12.04.24).

Lindian Resources Ltd. (2024b): Sustainability policy.

<https://static1.squarespace.com/static/58a516a859cc689ad6303dc4/t/643612141d99f858e5a3bdb0/1681265173685/Lindian+Sustainability+Policy+%281%29.pdf> (accessed 12.04.24).

Lindian Resources Ltd. (2024c): Environment policy.

<https://static1.squarespace.com/static/58a516a859cc689ad6303dc4/t/6434e598b931572ca37fbdd3/1681188250777/Lindian+Environment+Policy.pdf> (accessed 12.04.24).

Lindian Resources Ltd. (2024d): Community policy.

<https://static1.squarespace.com/static/58a516a859cc689ad6303dc4/t/6434d19ca2ea750d810a8055/1681183138970/Lindian+Community+Policy.pdf> (accessed 12.04.24).

Lindian Resources Ltd. (2024e): Health & Safety policy.

<https://static1.squarespace.com/static/58a516a859cc689ad6303dc4/t/6434e66d0326ea73813e89fc/1681188463102/Lindian+Health+and+Safety+Policy.pdf> (accessed 12.04.24).

### 3.8 Kasiya rutile (-graphite) residual placer project (Malawi)

Information as of 02/2024

#### 3.8.1 General project background

|                                    |                                                                                                                                                                                                                                                          |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Rutile                                                                                                                                                                                                                                                   |
| <b>Other commodities</b>           | Graphite                                                                                                                                                                                                                                                 |
| <b>Location</b>                    | Lilongwe, Malawi<br>13°36' S, 33°44' E, 1300 – 1350 m.a.s.l.                                                                                                                                                                                             |
| <b>License type</b>                | EL0561, EL0492, EL0609, EL0582, EL0657 (1,386 km <sup>2</sup> )                                                                                                                                                                                          |
| <b>License owner / operator</b>    | Sovereign Metals Ltd. (public company)                                                                                                                                                                                                                   |
| <b>Contact</b>                     | BGC Centre, Level 9, 28 The Esplanade<br>Perth, Western Australia 6000, Australia<br><a href="https://www.sovereignmetals.com.au">https://www.sovereignmetals.com.au</a><br><a href="mailto:info@sovereignmetals.com.au">info@sovereignmetals.com.au</a> |
| <b>Project status</b>              | Reserves Development – Pre-feasibility completed                                                                                                                                                                                                         |
| <b>Possible production by 2030</b> | unlikely                                                                                                                                                                                                                                                 |

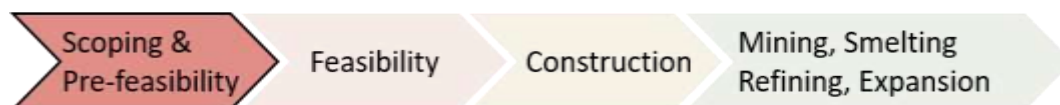


Figure 8. Kasiya project location, Malawi



### 3.8.2 Economic assessment

#### General project background:

The Kasiya project is currently the largest undeveloped natural rutile resources and the second largest flake graphite resources in the world. The current owner, Sovereign Metals Ltd., focusses on broad and contiguous zones of high-grade rutile and graphite, which occur across an area of over 201 km<sup>2</sup>. Sovereign's tenure covers the Lilongwe Plain, which generally has a flat, gently undulating topography. The underlying geology is dominated by paragneisses. A particular paragneiss unit is rich in rutile and graphite and is the primary source of both of these minerals. This area was deeply weathered during the Tertiary. A typical profile from top to base is generally soil (0-1 m) ferruginous pedolith (1-4 m), mottled zone (4-7 m), pallid saprolite (7-9 m), saprolite (9-25 m), saprock (25-35 m) and fresh rock (>35 m). Rutile mineralisation is concentrated in near surface (soil and pedolith), flat blanket-style bodies. Graphite is depleted near surface with grades improving from the mottled zone to the base of the saprolite zone, which averages about 22 m. The owner seeks investment for further exploration and metallurgical assessment as well as for mine development. A pre-feasibility study was completed in 09/2023.

#### Project description:

|                                                |                                                                                                                                    |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                               | Residual placer / eluvial heavy mineral deposits                                                                                   |
| JORC compliant reserves                        | 538 Mt @ 1.66 % rutile, 2.00 % graphite                                                                                            |
| Share of global rutile reserves                | 18.2 % ( <i>USGS estimate global rutile reserves of 49 Mt</i> )                                                                    |
| Share of global graphite reserves              | 3.4 % ( <i>USGS estimate global graphite reserves of 320 Mt</i> )                                                                  |
| JORC compliant resources                       | 1,271 Mt @ 0.72 % rutile, 1.15 % graphite                                                                                          |
| Share of global graphite resources             | 1.8 % ( <i>USGS estimate global graphite resources of 800 Mt</i> )                                                                 |
| Waste to ore ratio (whole orebody)             | Expected to be low due to near-surface location                                                                                    |
| Life of mine                                   | 25 years                                                                                                                           |
| Annual production                              | 12 Mt of ore (Stage 1: years 1-5), 24 Mt of ore (Stage 2: years 6-25); annual LOM production: 222 kt of rutile, 244 kt of graphite |
| Investment required                            | US\$ 597m (to first production)                                                                                                    |
| Post tax net present value (NPV)               | US\$ 1.6bn (based on rutile and graphite prices of US\$ 1,450/t and US\$ 1,290/t, respectively as well as 8 % discount)            |
| Share of global rutile production (over LOM)   | 38 % (recovery 100 %, expected) ( <i>USGS estimate global rutile production of 590 kt</i> )                                        |
| Share of global graphite production (over LOM) | 24.4 % (recovery 67.5 %, expected) ( <i>USGS estimate global graphite production of 1,000 kt</i> )                                 |

#### Mining and processing:

- Sovereign proposed hydraulic mining as the optimal method for the Kasiya rutile deposit. The material is loose, soft, fine and friable with no cemented sand or dense clay layers rendering it amenable to hydraulic mining. It is considered that the strip ratio would be zero or near zero. Dilution is considered to be minimal. Recovery parameters have not been factored into the estimate. However, the valuable minerals are readily separable due to their specific gravity



differential and are expected to have a high recovery through the proposed conventional wet concentration plant, as demonstrated by metallurgical test work.

- Metallurgical testwork confirmed premium specification rutile product yielding 96 % TiO<sub>2</sub> with a recovery rate of 98 % and with favourable product sizing of 50 % >118 µm (Kasiya North) and 128 µm (Kasiya South). Gravity separation separates rutile and graphite. The heavy mineral concentrate (rutile pre-concentrate) is then processed by electrostatic and magnetic separation resulting in the rutile product. Graphite is processed in a flotation circuit. After cleaning, a very coarse-flake graphite concentrate at 96.3 % TGC was produced at a recovery of 67.5 %. More than 60 % of the graphite concentrate is in the large to super-jumbo fractions.
- The operating expenditures are given at US\$ 404/t of combined rutile and graphite product FOB Nacala. The single processing costs are given at US\$ 88/t for rutile and US\$ 44/t for graphite. The remaining costs are made up of mining, transport and others like general administration. Sovereign assumes long-term rutile and graphite prices of US\$ 1,450/t and US\$ 1,290/t, respectively. This is within an expectable range for a high tonnage operation.

### **BGR assessment and comments:**

- The deposit is a low-grade (graphite) to high-grade (rutile), high-tonnage operation with an expected low waste to ore ratio and a relatively long life of mine (25 years). Resource expansions are likely due to further planned exploration drilling in a huge licence area. Although resources are less resilient than reserves in terms of their economic viability, it should be noted that Sovereign only considered 30 % of the current resources to estimate the life of mine.
- Sovereign assumes adequate long-term rutile price of US\$ 1,450/t compared to the current spot prices (>US\$ 1,600/t). Sovereign has signed non-binding MoUs with Hascor International and Chemours (45,000 t/a; both USA) and with Mitsui & Co Ltd. (30,000 t/a; Japan). Rio Tinto invested US\$ 40.4m to become a 15 % Strategic Investor in Sovereign.
- Kasiya is located east of Lilongwe and within 3 km of a major road and 6 km to a rail spur to the Nacala Port. The transporting logistics make up an estimated US\$ 98/t, almost a quarter of the operating costs. This puts it at a disadvantage compared to most rutile projects located directly by the sea. Due to the similar annual production of rutile and graphite and the relatively similar assumed sales prices for both products, the ratio of sales between rutile and graphite is around 1:1. This decreases the risks of low prices of a single commodity.

### 3.8.3 ESG assessment

Sovereigns general planning appear reasonable, no major ESG issues which would pose a risk that could not be handled by diligent management and operational practice were identified at this stage of the project. Though, detailed information on several aspects not yet available due to early stage of the project. The friable host rock allows production via hydraulic mining resulting in comparable low GHG emission.

| ESG issue                                                          | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Environmental management                                           | No reports on incidents found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Efficient use of energy, renewable energy, GHG emissions reporting | Power supply planned by hydropower from grid (~55 %), on-site solar-battery plant (~41 %), and back-up diesel (~3 %). Full production power requirement 56 MW. External service provider appointed to design and operate solar-battery plant. Transport planned via railway from mining site. 0.1 t CO <sub>2</sub> -eq per t natural rutile concentrate; 0.2 t CO <sub>2</sub> -eq per t graphite; considerable lower GHG emission compared to synthetic rutile or hard-rock deposits due absence of drilling, blasting, and crushing etc., savings stated as 95 % for rutile and 60 % for Graphite.                                  |
| Water management and consumption                                   | Sub-tropical humid climate; low water stress, however stormwater related risks. Closed process water circuit; water storage facility to store process water in wet season (December to March), until production Stage 2 catchment of rainwater will be sufficient for operation, when full production is reached and in case of low rainfall pumping of additional process water from the Bua River might be necessary. Production requirements 8.2 Mm <sup>3</sup> /a for stage 1, 16.3 Mm <sup>3</sup> /a for stage 2; storage capacity is designed for Stage 2 requirements. Stormwater management considering 50-year flood lines. |
| Pollution prevention                                               | Tailings designated for disposal are stated as “benign” by Sovereign; no detailed information on tailing composition and chemistry available. Flotation technology may imply use of hazardous reagents, in case of graphite flotation usually fuel oil or kerosene are applied.                                                                                                                                                                                                                                                                                                                                                        |
| Air quality                                                        | Hydraulic mining will probably create negligible dust emissions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Tailings management                                                | External TSF in first two years (30 %), then in-pit storage (70 %); TSF will be designed according to International Financial Corporation Guidelines, Canadian Dam Association Guidelines, and Global Industry Standard on Tailings Management.                                                                                                                                                                                                                                                                                                                                                                                        |
| Waste management                                                   | No specific information on waste management at this project stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Hazardous materials management                                     | Flotation and use of required reagents is considered low risk assuming responsible handling; no information on used reagents available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Noise and vibration                                                | Hydraulic mining is not noise / vibration intensive compared to conventional mining.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Protected areas and biodiversity                                   | The project is not located in or close to a key biodiversity area or other designated protected area. Mainly agricultural land use in the mining area.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| ESG issue                                                 | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mine closure                                              | Mine closure plan envisages progressive rehabilitation of in-pit TSF during operation; an average seven year time span from start of mining till rehabilitation of the area is planned. Rehabilitation will focus on restoring agricultural land use post-mining; for this purpose a 2 m layer of 70 % sand and 30 % followed by 10 cm of stored topsoil is planned. It will be important to ensure sufficient fertility for post-mining land use.                                                                                                  |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Community health, safety and security                     | Rural area with majority of population being subsistence farmers, some commercial farming activities. Several smaller settlement in the surroundings of the mining area.                                                                                                                                                                                                                                                                                                                                                                            |
| Dialogue and engagement with communities and stakeholders | Consultation with the Malawian government on early stage permitting, social, environmental and fiscal aspects of the project ongoing. Sovereign Metals started community engagement and states a general positive acceptance.                                                                                                                                                                                                                                                                                                                       |
| Land acquisition and involuntary resettlement             | Mine plan developed to avoid larger settlements. Relocation of smaller settlements necessary; development of resettlement action plan commencing.                                                                                                                                                                                                                                                                                                                                                                                                   |
| Occupational health & safety management                   | No specific information on OHS management available at this stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Workers' rights                                           | Malawi scores 68/100 in the Labour Rights Index. No indication of non-compliance with fundamental workers' rights by Sovereign Metals found.                                                                                                                                                                                                                                                                                                                                                                                                        |
| Gender and diversity                                      | Currently 30 % of staff female (hiring of majority of the staff for operations still pending).                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Local value added and community development               | Sovereign Metals estimates the creation 1,100 direct jobs for operational phase (95 % planned to be Malawian), and significant additional indirect job creation is anticipated; training and graduation program will be focused on building local skill capacities. Intendent conclusion of Community Development Agreement will include local infrastructure, business support, water provision, healthcare and education. CSR cost are estimated at US\$ 80m in the scoping study. 5 % royalty and 0.45 % royalty for community development fund. |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Legal compliance                                          | Issuing of mining license pending; ESIA in data collection stage; environmental and social baseline studies have commenced.                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Management practices                                      | Standards aimed for DFS: IFC Performance Standards on Environmental and Social Sustainability; World Bank Group Environmental, Health and Safety Guidelines; Equator Principles; ICMM principles.                                                                                                                                                                                                                                                                                                                                                   |
| Transparency and reporting                                | Listed on ASX; information on financial accounts and shareholder structure available. Adherence to the Task Force on Climate-Related Financial Disclosures intended.                                                                                                                                                                                                                                                                                                                                                                                |
| Business ethics                                           | Malawi scores 34/100 in the Corruption Perception Index; Malawi is an EITI country. No indication of unethical practice from Sovereign Metals found. Anti-Bribery and Corruption, and Whistleblower policies in place.                                                                                                                                                                                                                                                                                                                              |

Table 13. ESG features of Kasiya project, Malawi

### 3.8.4 Infrastructure assessment

#### Potential Investment Needs:

- **Road Infrastructure:** Excellent access to sealed roads and short haulage distances to railhead. A few upgrades on some of the gravel roads within the proximity should be considered in project planning.
- **Water Supply:** Investments required for the construction of the diversion pump and pipeline system from the nearby Bua River. Furthermore, investments could be considered for groundwater use via boreholes to compensate water losses.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | Kasiya Rutile-Graphite Project is a greenfield mining project located near Lilongwe, the capital city of Malawi. The project site is in the direct vicinity of the Nacala Logistic Corridor and powerline with high capacity.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Transport                 | The majority of Sovereign's ground holding occurs within a 75 km radius from Malawi's capital city of Lilongwe. This provides the Company with excellent access to sealed roads (M12 and M1) and short haulage distances to the Nacala Logistics Corridor passing through Malawi to Nacala Port in Mozambique.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Airport                   | Kamuzu International Airport is an international airport serving Lilongwe. It serves for transportation of passengers and cargo. It is the nearest airport to the project and can be utilised for travels.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Rail access               | The Nacala Logistic Corridor was recently refurbished. It is a 912 km rail line with investment of over US\$ 4.4bn for the purpose of transporting coal from mines in western Mozambique east to the port of Nacala via Malawi. The corridor stretches from Moatize, Mozambique and Chipata, Zambia and passes through Lilongwe in Malawi to the Port of Nacala on the Indian Ocean. The railway in Malawi is operated by Central East African Railways (CEAR), which is controlled by Vulcan Minerals (a subsidiary of Indian coal company Jindal Group). The rail includes an operating line north to Lilongwe and passing within 25 km of Sovereign's licence areas. Access to the existing Nacala Logistic Corridor has the significant advantage of reducing upfront capital cost for transport development. Sovereign will, for the duration of the operation, rail rutile and graphite products directly from a purpose-built rail station at the mine site eastward via 6 km railway to Nacala Logistic Corridor and from there to the port of Nacala. |
| Port                      | Exporting of the product will be via the deepwater port of Nacala in Mozambique. The deepwater port of Nacala is at the eastern end of the Nacala Logistic Corridor and is the deepest port in Southern Africa. The port's infrastructure extends for approximately 600 hectares at the bay of Nacala, Nacala-a-Velha district, northern Mozambique. With deep waters and multiuse standard, it allows the access of several companies to its infrastructure. It was designed to receive and export about 18 million t of coal, in addition to general cargo and especially daily passenger transportation.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Energy                    | The project site has access to a major power line of the national grid (hydro-source) with high capacity. 56 MW of power will be required for the completed mining complex, which will be supplied by a grid connected hybrid solution (photovoltaic, BESS and diesel backup) designed by the independent power producer JCM. JCM has recently                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | commissioned the 60 MW Salima solar project and the 20 MW Golomoti photovoltaic and BESS project, both in Malawi.                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| GHG emission | Sovereign is aiming to develop a low-CO <sub>2</sub> operation. The project will benefit from renewable energy sources via a grid-connected hybrid solution with 96.6 % solar and hydro power mix while diesel generators will act as backup. Kasiya has a geological benefit with both natural graphite and rutile hosted in soft, friable saprolite material at surface that can be mined (hydraulic-mining), beneficiated, and purified with a considerably lower carbon footprint than hard-rock operations or synthetic graphite and rutile production. |
| Water        | Sovereign plans to construct a water dam to capture and store process water from run-off. A diversion pump and pipeline system are also planned to be constructed to extract water when required from the nearby Bua River. Besides that, investments could be considered for groundwater use via boreholes to compensate water losses.                                                                                                                                                                                                                      |

**Table 14. Infrastructure assessment of Kasiya project, Malawi**

### 3.8.5 Further reading

Sovereign Metals Ltd. (2022a): Rutile Offtake and Marketing Alliance with Major Japanese Trading House. <http://www.investi.com.au/api/announcements/svm/c8de7dbe-715.pdf> (accessed: 15.09.2023)

Sovereign Metals Ltd. (2022b): Sovereign Signs Rutile Offtake MOU with Chemours. <http://www.investi.com.au/api/announcements/svm/a3e00025-b16.pdf> (accessed: 15.09.2023)

Sovereign Metals Ltd. (2022c): Kasiya Expanded Scoping Study Results. <http://www.investi.com.au/api/announcements/svm/c6f18bca-8aa.pdf> (accessed: 15.09.2023)

Sovereign Metals Ltd. (2023a): Kasiya Pre-Feasibility Study Results. <https://www.investi.com.au/api/announcements/svm/b26383be-db2.pdf> (accessed: 08.02.2024)

Sovereign Metals Ltd. (2023b): Rio Tinto to Invest \$40.4 Million and become a 15% Strategic Investor in Sovereign. <http://www.investi.com.au/api/announcements/svm/66db5ffa-561.pdf> (accessed: 15.09.2023)

Sovereign Metals Ltd. (2023c): Kasiya Indicated Resource Increased by over 80%. <http://www.investi.com.au/api/announcements/svm/eb18394c-1f0.pdf> (accessed: 15.09.2023)

### 3.9 Lubalisi Ni (-Co-Cr-PGE) laterite/sulphide project (Tanzania)

Information as of 03/2024

#### 3.9.1 General project background

|                                    |                                                                                                                                                                                                                                                  |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodities</b>         | Nickel                                                                                                                                                                                                                                           |
| <b>Other commodities</b>           | Cobalt, chromium, PGE, copper, gold                                                                                                                                                                                                              |
| <b>Location</b>                    | Kigoma, Western Tanzania<br>05°54' S, 30°5' E, 1,050 – 1,150 m.a.s.l.                                                                                                                                                                            |
| <b>License type</b>                | Prospecting licenses PL 10695/2015, 11444/2020, 111810/2022 (Kapalagulu, Lubalisi, Luegele);<br>Application for Mining Licences submitted in 03/2024                                                                                             |
| <b>License owner / operator</b>    | Lubalisi Resources Ltd; subs. of Rift Energy Metals Ltd                                                                                                                                                                                          |
| <b>Contact</b>                     | 1st Floor Kimbiji, 344 Ghuba Road, PO Box 23197,<br>Kinondoni, Dar es Salaam,<br><a href="https://www.lubalisiresources.com">https://www.lubalisiresources.com</a><br><a href="mailto:info@lubalisiresources.com">info@lubalisiresources.com</a> |
| <b>Project status</b>              | Scoping phase                                                                                                                                                                                                                                    |
| <b>Possible production by 2030</b> | unlikely                                                                                                                                                                                                                                         |

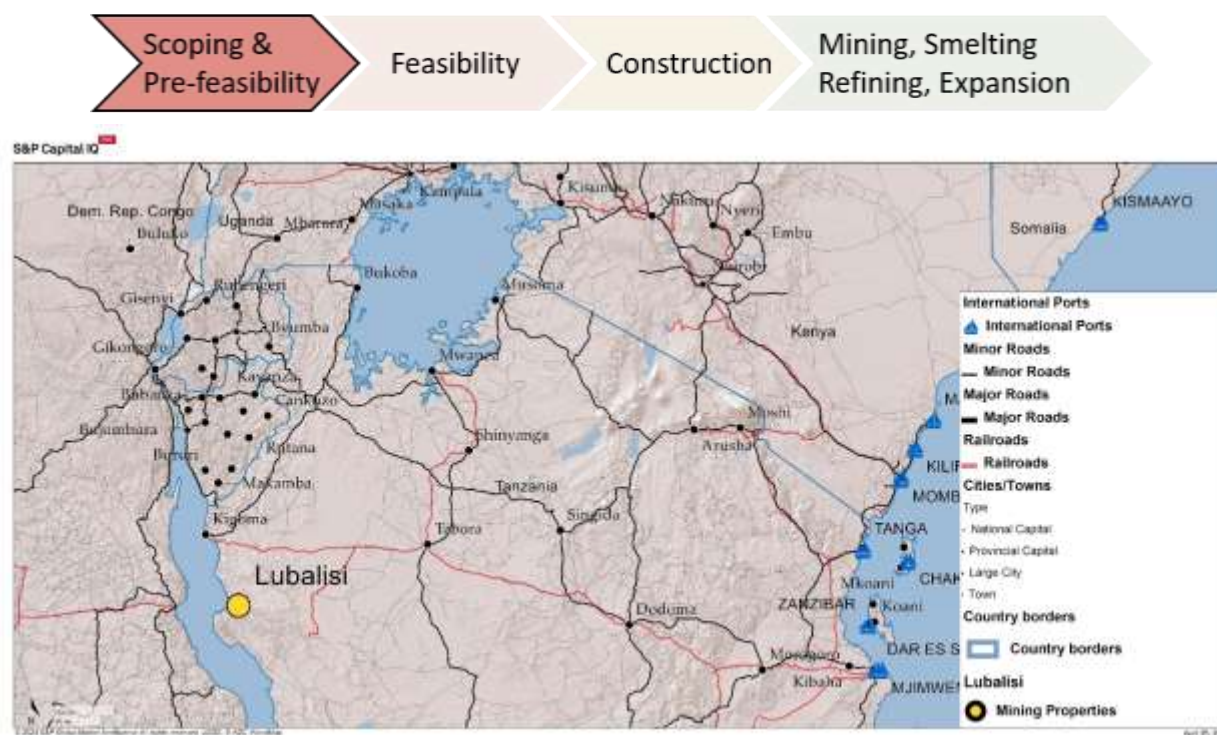


Figure 9. Lubalisi project location, Tanzania



### 3.9.2 Economic assessment

#### General project background:

Exploration of the Kapalagulu Intrusion started in 1900. The main ore deposit at the Lubalisi project contains two different types of Ni-Co-Cr-PGE mineralisation. One is a nickel laterite deposit with a flat-lying surface layer of oxide Ni-Co-Cr-PGE mineralisation with a thickness of about 40 m and the other is a folded layer of chromite and sulphide-rich harzburgite containing magmatic Cu and Ni sulphides and disseminated and reef-like PGE mineralisation. The sulphide mineralisation layer has a thickness of about 200 m. There is a lower 80 m thick PGE-rich interval that contains PGE reefs and an upper 120 m thick Ni-and-Cu-rich interval. The owner seeks investment to complete a DFS. The following information only refers to the laterite deposit.

#### Project description:

|                                                       |                                                                                                                         |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                                      | Nickel laterite                                                                                                         |
| JORC compliant resources reported at 0.6 % Ni cut-off | 81.1 Mt @ 0.83 % Ni, 0.03 % Co, 3PGE 0.19 ppm, 1.6 % Cr                                                                 |
| Share of global nickel resources                      | 0.19 % for 81.1 Mt ( <i>USGS estimate global Ni resources of 350 Mt</i> )                                               |
| Share of global cobalt resources                      | 0.09 % for 81.1 Mt ( <i>USGS estimate global Co resources of 25 Mt</i> )                                                |
| Share of global chromium resources                    | 0.02 % for 81.1 Mt ( <i>USGS estimate global Chromite resources of 12 Bt (5.52 Bt Cr content)</i> )                     |
| Waste to ore ratio (whole orebody)                    | ~1.83 for 119.8 Mt                                                                                                      |
| Annual production applying HPAL                       | 250,735 t Cr, 19,678 t Ni, 618 t Co                                                                                     |
| Life of mine                                          | >20 years                                                                                                               |
| Investment required                                   | US\$ 15-20m to conduct a bankable feasibility study                                                                     |
| Net present value                                     | US\$ 1,046m (7% discount rate), applying a long-term constant Ni price of 22,500 US\$/t and a Co price of 48,000 US\$/t |
| Share of global Cr production                         | 0.60 % ( <i>USGS estimate global Cr production of 41.9 Mt in 2022</i> )                                                 |
| Share of global Ni production                         | 0.61 % ( <i>USGS estimate global Ni production of 3.3 Mt in 2022</i> )                                                  |
| Share of global Co production                         | 0.31 % ( <i>USGS estimate global Co production of 197,000 t in 2022</i> )                                               |
| Value addition potential                              | Copper, cobalt, nickel and PGE-rich sulphide harzburgite can be mined at a later stage in large open pits.              |

#### Mining and processing:

- Conventional open pit methods employing drilling, blasting, and hauling. The higher-grade ore (>0.75 % Ni) will be hauled directly to the plant where 25 % of the material will be tipped directly into the crusher bin, while the balance will be stockpiled for blending of low grade ore. Material below the cut-off will be used for the construction of the Tailings Storage Facility (TSF) and stockpiled for potential reclamation at the end of the mine life. Waste rock will be transported to one of two dedicated waste stockpiles.



- The selected process for recovering chromite, nickel and cobalt from laterite ore in the Lubalisi Project involves ore preparation with chromite and some PGE recovery, and subsequently a high- pressure acid leach (HPAL), neutralisation, precipitation and tailings disposal to recover Ni, Co and additional PGE.

### **BGR assessment and comments:**

- The deposit is a low-grade operation with a relatively low waste to ore ratio of ~1.8. The advantage of the project is the availability of several critical raw materials in one deposit, which can be mined in an open pit. However, with the relatively low grades of Ni and Co (the main commodities), the project could potentially face difficulties to remain economic over the life of mine due to price fluctuation. The project has to compete with huge nickel laterite deposits in Indonesia, which have logistical advantages.
- The HPAL process for the recovery of nickel and cobalt from nickel oxide laterite ores is more challenging due to its high capital expenditure, especially high energy and reagent costs and environmental impact. The supply of acids and energy faces additional challenges due to the location of the project with poor infrastructure and long distances to the next port. However, it is proposed that sulphuric acid be produced at site from waste pyrrhotite concentrate from the Kabanga nickel mine, neutralising limestone will be derived from nearby quarries. For the HPAL process, this is becoming increasingly important as there are large resources of low-grade Ni ores worldwide, and the product of this process, mixed sulphide product (MSP), is an important precursor material for Ni sulphate, which is a crucial component for the production of cathodes for lithium ion batteries. Chromite Sand and some PGE and cobalt can be recovered by gravity circuits. It is possible to recover Pt and Pd by adding Cl to the autoclaves.
- The sulphide-bearing harzburgite layer, located below the laterite, contains a large low-grade Ni-Cu and PGE deposit that might be mined in open pits at a later stage. No information about the PGE and Ni sulphide resource and ore processing route are available so far.
- Transport of the material is possible via the lakeside main road and lake barges to the railway head at Kigoma port. Direct access to the mining area is by lake ferries and a lakeside main road from Kigoma Port. A new concrete jetty has been built close to the project site. The lakeside road is a gravel main road and is maintained throughout the year by Tanroads. Closest railroad access is Kigoma Port (120 km from site) which is connected to the ocean port of Dar es Salaam about 1,300 km away. The railway line is being upgraded to standard gauge.

### **3.9.3 ESG assessment**

As the project is in a scoping phase only limited information is available. No major ESG issues that would preclude responsible investment were identified at this stage of the project. The ESIA Scoping Report for the Lubalisi Nickel Mining project, was conducted in 2023 to obtain an EIA

certificate, in accordance with the Environmental Management Act and Audit Regulations. It was submitted to the National Environment Management Council (NEMC) for approval, but was not available for this assessment.

The mining area is located in an area classified as a Key Biodiversity Area of international significance. Water stress level is low, however, increased water demand for HPAL technology is expected but shall be provided from Lake Tanganyika. High potential rainfall events might require respective water management. The area is scarcely populated, but loss of land for cattle farming and some relocation of local population will be necessary.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Environmental Management                                           | ESIA report was submitted to the National Environment Management Council for review and approval. The report is not available at the time of preparing this factsheet. However, the company has shared information from this report for preparing this factsheet.                                                                                                                                                                                                                      |
| Efficient use of energy, renewable energy, GHG emissions reporting | Electricity is generated by natural gas (62 %) and hydropower (36 %). Company presentation (2022) suggests supply from the nearby Malagarasi hydroelectric power plant or hybrid solar/diesel generators.                                                                                                                                                                                                                                                                              |
| Water management and consumption                                   | Water stress level in western Tanzania is low, however it is a region with high precipitation (Oct until May) and extremely high riverine flood risk, respective storm water management might be relevant. ESIA report identified that increased usage of water resources could lead to competition and potential conflicts. However, water can be supplied from the nearby Lake Tanganyika. No information on water demand and management are available at this stage of the project. |
| Pollution prevention                                               | Impact for AMD is currently considered low risk. For mining of the sulphide mineralisation, a more detailed assessment must be carried out.                                                                                                                                                                                                                                                                                                                                            |
| Air quality                                                        | Operations may result in significant noise and air pollution. Respective measures to prevent air pollution effects, especially for surrounding communities is envisaged.                                                                                                                                                                                                                                                                                                               |
| Tailings management                                                | Tailings storage facility for the HPAL residues is envisaged. Low-grade ore will be stockpiled for potential reclamation at the end of the life. Waste will be transported to one of two dedicated waste stockpiles and will be used to construct the TSF.                                                                                                                                                                                                                             |
| Waste management                                                   | Efficient and environmentally friendly waste management is envisaged, including identification, separation, quantification, and managing domestic and process waste streams, with a focus on reduction, reuse, and recycling.                                                                                                                                                                                                                                                          |
| Hazardous materials management                                     | HPAL process for Ni and Co recovery implies the use of chemicals for the process as e.g. sulphuric acid. These materials as well as waste water have to be disposed or reused. Sulphuric acid will be neutralised by crushed limestone to produce inert gypsum, which will be stored in the TSF.                                                                                                                                                                                       |
| Noise and vibration                                                | Operations may result in significant noise. Scarcely populated area, considered low risk.                                                                                                                                                                                                                                                                                                                                                                                              |

| ESG category                                                                                                       | Assessment                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Protected areas and biodiversity  | The project is located close to the Mahale Mountains National park and in the Greater Mahale Key Biodiversity Area, which is classified as a Key Biodiversity Area of international significance and hosts endangered mammals and birds (IUCN red list).                                                    |
| Mine closure                                                                                                       | Loss of land for cattle grazing is a concern, as the mining activities may limit available land. The focus of the rehabilitation plan is on preserving the environment and regaining land soil fertility for agriculture.                                                                                   |
| <b>Social and socio-economic issues</b>                                                                            |                                                                                                                                                                                                                                                                                                             |
| Community health, safety and security                                                                              | The city closest to the mining area is Kigoma, a town with more than 200.000 inhabitants. Potential negative impacts from the mine on local communities are, based on the distance (130 km), considered as low risk. However, several small villages and hamlets are present in the surrounding area.       |
| Dialogue and engagement with communities and stakeholders                                                          | The local population expects Rift Energy Metal's local subsidiary to contribute to community development in areas like education, health, and infrastructure.<br>There is an anticipation that the company will expand its community relations department to better address community issues.               |
| Land acquisition and involuntary resettlement                                                                      | The project might lead to displacement and relocation of local populations. Loss of land for cattle grazing is a concern, as the mining activities may limit available land. While there are designated grazing areas, the need for more land for cattle development remains.                               |
| Occupational health & safety management                                                                            | No information available at this stage of the project.                                                                                                                                                                                                                                                      |
| Workers' rights                                                                                                    | Tanzania scores 74/100 in the Labour Rights Index, reasonable access to decent work. No further information available.                                                                                                                                                                                      |
| Gender and diversity                                                                                               | The company states to provide equal opportunity to all employees and not discriminate based on age, colour, creed, disability, ethnic origin, gender, marital status, national origin, political belief, race, religion or sexual orientation unless required for occupational reasons as permitted by law. |
| Local value added and community development                                                                        | Creation of employment opportunities: The project is expected to provide both direct and indirect employment opportunities, including health facilities, schools, electricity and water supply.                                                                                                             |
| <b>Governance</b>                                                                                                  |                                                                                                                                                                                                                                                                                                             |
| Legal compliance                                                                                                   | No indication of any breaches of law found.                                                                                                                                                                                                                                                                 |
| Management practices                                                                                               | No information available at this stage of the project.                                                                                                                                                                                                                                                      |
| Transparency and reporting                                                                                         | The company operates privately and has not offered any shares to the public. The company is not listed at any stock exchange. Financial reports are not publicly accessible and must be requested from the company directly.                                                                                |
| Business ethics                                                                                                    | Tanzania scores 40/100 in the corruption perception index; Tanzania is an EITI country; no indication of unethical practices found.                                                                                                                                                                         |

Table 15. ESG features of Lubalisi project, Tanzania

### 3.9.4 Further reading

Lubalisi Resources Ltd (2022): Work progress on PL 10695/2015 - Lubalisi Project - Kapalagulu Intrusion.

[https://www.lubalisiresources.com/files/ugd/f82c9f\\_ffd16626b2ac432ca9fb9ec9706fe2d8.pdf](https://www.lubalisiresources.com/files/ugd/f82c9f_ffd16626b2ac432ca9fb9ec9706fe2d8.pdf)  
(accessed 19.03.2024)

Lubalisi Resources Ltd (2024): Project Homepage. <https://www.lubalisiresources.com/>  
(accessed 19.03.2024)

Rift Energy Metals Ltd “Lubalisi disseminated sulphide nickel and PGE mineralisation – Resource development for a large open pit Ni-PGE mine”, February 2024.

Rift Energy Metals Ltd “Lubalisi Project Open pit – Ni-Co-Cr-PGE – Kapalagulu Intrusion Western Tanzania”, February 2024.

### 3.10 Maboumine (Mabounié) Nb-REE carbonatite project (Gabon)

Information as of 02/2024

#### 3.10.1 General project background

|                                    |                                                                                                                                                                                                           |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Niobium, REE                                                                                                                                                                                              |
| <b>Other commodities</b>           | Uranium, phosphate, titanium, tantalum, scandium                                                                                                                                                          |
| <b>Location</b>                    | Moyen-Ogooué, Gabon<br>0°45' S, 10°34' E, 0 – 100 m.a.s.l.                                                                                                                                                |
| <b>License type</b>                | Permis de Recherche Mabounier (exploration license, ~400 km <sup>2</sup> )                                                                                                                                |
| <b>License owner / operator</b>    | Maboumine Company<br>(100 % Société Equatoriale des Mines (Gabon gov.))                                                                                                                                   |
| <b>Contact</b>                     | Boulevard de la Nation (Bord de Mer), BP: 2130,<br>Libreville, Gabon<br><a href="https://gabonmining.com/">https://gabonmining.com/</a><br><a href="mailto:info@gabonmining.com">info@gabonmining.com</a> |
| <b>Project status</b>              | Prefeasibility completed in 2016, project on hold                                                                                                                                                         |
| <b>Possible production by 2030</b> | unlikely                                                                                                                                                                                                  |

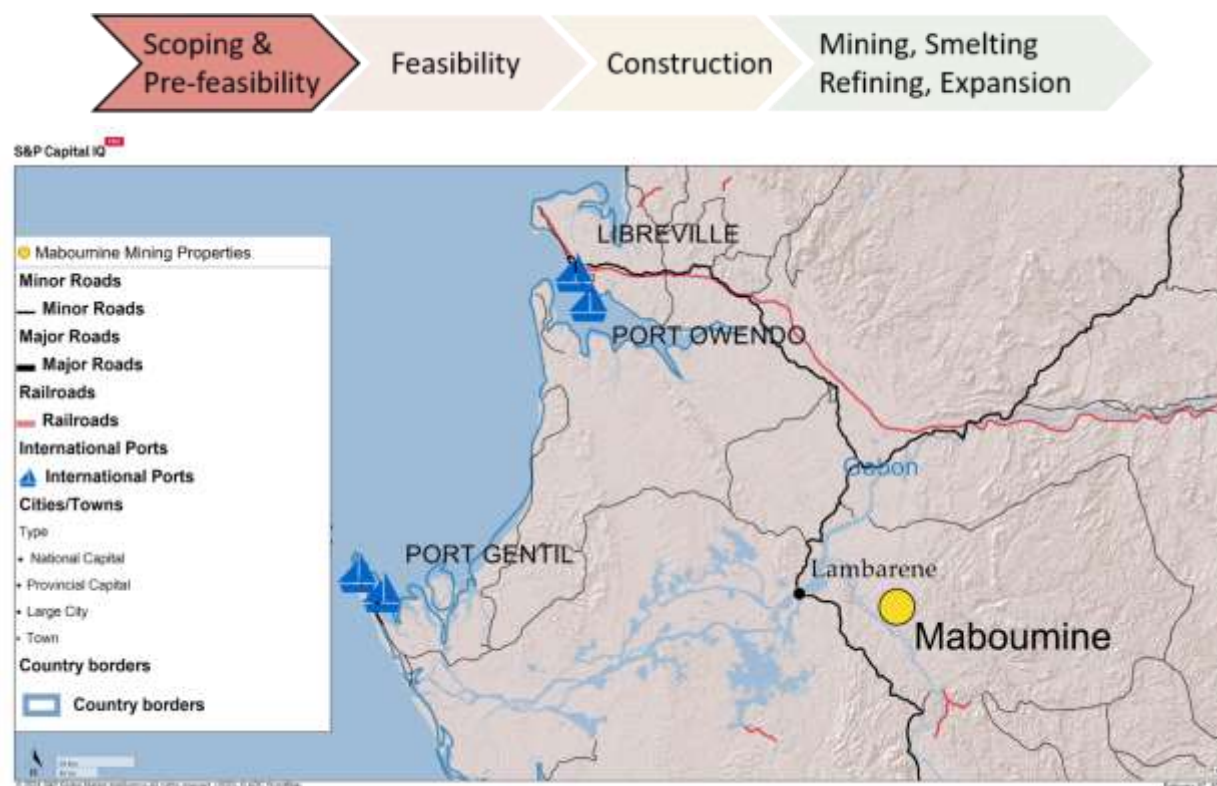


Figure 10. Maboumine project location, Gabon

### 3.10.2 Economic assessment

#### General project background:

The Maboumine project was discovered in 1986 and initially explored for phosphates by SOMIMO (Société Minière Du Moyen Ogoué). From 2005, Eramet, through its subsidiary Comilog, extensively explored the deposit for rare earths, niobium and phosphate. The host rock profile comprises a ~30 m thick superficial banded layer containing phosphate rocks and magnetite lenses. This layer is underlain by a ~13 m thick phosphate layer, which contains apatite mineralisation. The bottom layer is represented by the main bedrock carbonatite. Niobium is predominantly contained in pyrochlore and ferrocolumbite rich rock. The rare earths are hosted in pyrochlore, apatite and crandallite. Eramet developed a metallurgical process, which considers the recovery of most of the value-metals present at Maboumine. In 2016, the company completed an updated prefeasibility study, which indicated that the project had a certain economic viability from the operator's perspective. From then on, Eramet sought partnerships with the Gabonese government and third parties to mitigate potential risks associated with further investment into the project. After Eramet sold its shares in the Maboumine project to the Gabonese government in 2022, a buyer and/or partner is being sought with whom the government of Gabon can resume activities at the site.

#### Project description:

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Polymetallic (weathered) carbonatite deposit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Resources (unknown code)           | 192 Mt @ 1.2 % Nb <sub>2</sub> O <sub>5</sub> , 1 % REO,<br>100 Mt @ 20 % P <sub>2</sub> O <sub>5</sub> , 0.5 % Nb <sub>2</sub> O <sub>5</sub> , 0.6 % REO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Waste to ore ratio (whole orebody) | Expected to be relatively low                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Annual production                  | 2 Mt of ore, 1 Mt of concentrate, 14,500 t of ferroniobium,<br>18,000 t of separated REO (several rare earths oxides)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Life of mine                       | 20 years, extendable to more than 40 years considering<br>expansion to the North and South zones                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Investment required                | US\$ >3bn (CAPEX for start of mine production, old estimate)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Net present value (NPV)            | US\$ 2bn (based on a discount rate of 12 % and generated<br>revenues of US\$ 1.5bn/a)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Share of global niobium production | 13.1 % (concentrate to FeNb recovery 90 %)<br>(USGS estimate global Nb <sub>2</sub> O <sub>5</sub> production of 119,700 t)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Share of global REO production     | 6.4 % (concentrate to separated REO recovery 90 %)<br>(USGS estimate global REO production of 280,000 t)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Value addition potential           | Earlier studies envisaged the production of separated rare<br>earths (44.6 % CeO <sub>2</sub> , 19.0 % La <sub>2</sub> O <sub>3</sub> , 5.2 % Pr <sub>6</sub> O <sub>11</sub> , 19.7 % Nd <sub>2</sub> O <sub>3</sub> ,<br>2.9 % Sm <sub>2</sub> O <sub>3</sub> , 0.8 % Eu <sub>2</sub> O <sub>3</sub> , 2.1 % Gd <sub>2</sub> O <sub>3</sub> , 0.2 % Tb <sub>4</sub> O <sub>7</sub> , 1.0 %<br>Dy <sub>2</sub> O <sub>3</sub> , 0.1 % Ho <sub>2</sub> O <sub>3</sub> , 0.3 % Er <sub>2</sub> O <sub>3</sub> , 0.0 % Tm <sub>2</sub> O <sub>3</sub> , 0.2 % Yb <sub>2</sub> O <sub>3</sub> ,<br>3.7 % Y <sub>2</sub> O <sub>3</sub> ) and ferroniobium, but also the potential processing<br>of tantalum, scandium, titanium and phosphates. |

**Mining and processing:**

- Eramet presented a scenario, which envisaged conventional open pit mining with a low waste to ore ratio for an initial mine life of 20 years, extendable to 40 years when moving to the North and South zones of the deposit.
- Eramet developed a hydrometallurgical process, which includes five patents and a fluorine free Nb/Ta purification process. The flow sheet comprises raw ore beneficiation by magnetic and gravimetric separation (removal of magnetite, ilmenite and quartz), a sulphuric acid leaching unit to solubilise niobium, uranium and rare earths elements, a solid-liquid separation and a niobium concentrate precipitation (with subsequent purification to produce a clean niobium oxide concentrate and a potential tantalum separate). The purified niobium concentrate is further processed to ferroniobium by aluminothermic reduction. The rare earths leach solution is purified and a mixed rare earths solution is recovered via solvent extraction. The mixed rare earths solution feeds the rare earths separation plant, which recovers the individual rare earths oxide products.
- This process obtains a recovery of ~90 % from ore concentrate to commercial niobium and rare earths products and allows for uranium and scandium recovery by solvent extraction in additional units (optional). Considering the production of 14,500 t/a of ferroniobium and 18,000 t/a of separated REO, Eramet estimated operation expenditures of ~US\$ 17,000/t of product comparing to a revenue of ~US\$ 46,200/t of product.

**BGR assessment and comments:**

- The deposit is a medium-grade, high-tonnage operation with an expected relatively low waste to ore ratio. The long life of mine (>20 years) can be positive for the development of the region. Given that only resource estimates have been made to date, infill drilling and reserves development are mandatory.
- The rare earths market has been subject to strong price fluctuations over the last 5 years. As the last economic assessment was carried out almost 8 years ago, the estimates do not reflect current market conditions. An economic reassessment of the project taking into account current commodity prices of the different rare earths oxides is highly recommended.
- The Mabounié deposit is located 35 km east of the town of Lambaréné; a technical connection to the national power grid should be possible. The Gabonese government is currently planning long-term investments in the national infrastructure, including the expansion of hydropower, from which the project could benefit. Water is expected to be supplied from the Ngounie River. A 265 km long shipping route from Port Gentil along the Ngounie River was considered for the transport of reagents and products.



### 3.10.3 ESG assessment

An ESIA was carried out by the previous owner Comilog before 2016, but is not available for review. Therefore, information on several ESG issues is missing or incomplete and this assessment is partly based on assumptions and generalisations. To this point no severe ESG risks were identified, which would exclude a responsible investment. Special attention in further studies should be given to required pollution prevention measures from construction phase until post-closure. The proximity of the protected Bas-Ogooué wetlands downstream, make this imminent important.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Environmental management                                           | Operator not yet known; no information on management practices.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Efficient use of energy, renewable energy, GHG emissions reporting | Remote area, connection to grid (42 % hydro) might be difficult; construction of onsite solar power plant should be possible in general (regional power potential around 3.5 kWh/kWp), however, has to be considered against clearing of respective area.                                                                                                                                                                                                                                                                         |
| Water management and consumption                                   | Humid tropical area, with low water stress. No detailed information on water demand in previous planning, however, water availability will probably be no issue and anticipated leaching technology allows very high recycling rates in general. Area of high riverine flood risk, stormwater management might become challenging during rainy season; required to be assessed in detail in further studies.                                                                                                                      |
| Pollution prevention                                               | Th/U content in REE deposits implies natural radioactivity and associated risks; no information on the specific content of the deposit available. Previous study plans onsite cracking and leaching plant to separate Nb and potentially U and REE from the concentrate; leaching technology implies use of hazardous chemicals such as acids and cyanides. Special care needed to prevent contamination of the surrounding environment, especially local streams; required measures to be assessed in detail in further studies. |
| Air quality                                                        | Dust mitigation measures may be required depending on the radioactivity in the dust emitted from mining operation or TSF.                                                                                                                                                                                                                                                                                                                                                                                                         |
| Tailings management                                                | Dependable on the radioactivity remaining in the tailings special care on stormwater management and prevention of dust emissions is required.                                                                                                                                                                                                                                                                                                                                                                                     |
| Waste management                                                   | Operator not yet known; no information on management practices.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Hazardous materials management                                     | To ensure the prevention any spill of process water / leaching solution a multi-barrier system of prevention measures is highly advisable.                                                                                                                                                                                                                                                                                                                                                                                        |
| Noise and vibration                                                | Need for noise protection measures for local fauna should be investigated in detail in further studies.                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Protected areas and biodiversity                                   | Project located in dense rainforest, satellite images does not indicating any significant degradation by human activities. Located in close vicinity to the Bas-Ogooué (RAMSAR site – wetlands of international importance), close to the Ngounie river that runs into the Bas-Ogooué, and several of its                                                                                                                                                                                                                         |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | smaller tributaries; prevention of any contamination especially of the streams is imperative. Previous ESIA (carried out before 2016) identified four endangered and two critically endangered species in the project area.                                                                                                                                                       |
| Mine closure                                              | Operator not yet known; no information on management practices. Effective sealing and monitoring of TSF and other remaining residues required to prevent post-mining contamination.                                                                                                                                                                                               |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                   |
| Community health, safety and security                     | Very scarcely populated area; no indication of significant human settlements. Previous ESIA (carried out before 2016) identified potential impacts as “acceptable”; study was not available for review. Next major settlement is the regional capital of Lambaréné (around 39,000 inhabitants in 2013) 35 km west of the project area and downstream in the water catchment area. |
| Dialogue and engagement with communities and stakeholders | Operator not yet known; no information on stakeholder engagement to this point.                                                                                                                                                                                                                                                                                                   |
| Land acquisition and involuntary resettlement             | Indication of a few very small settlements in the area; need for resettlement dependable on final extension of the mine and actual settlements in the area; risk can generally be expected to be low.                                                                                                                                                                             |
| Occupational health & safety management                   | Operator not yet known; no information on management practices.                                                                                                                                                                                                                                                                                                                   |
| Workers' rights                                           | Gabon scores 70/100 in the Labour Rights Index. Operator not yet known; so no evidence of practice yet.                                                                                                                                                                                                                                                                           |
| Gender and diversity                                      | Operator not yet known; so no evidence of practice yet.                                                                                                                                                                                                                                                                                                                           |
| Local value added and community development               | Area remote and very scarcely settled, therefore potential for community development presumably low and value addition mainly related to national level.                                                                                                                                                                                                                          |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                   |
| Legal compliance                                          | Exploration licence available. Difficulties of previous owner to develop the project into production appear to be economically driven and not by permitting.                                                                                                                                                                                                                      |
| Management practices                                      | Operator not yet known; no information on management practices.                                                                                                                                                                                                                                                                                                                   |
| Transparency and reporting                                | Operator not yet known; no information on management practices.                                                                                                                                                                                                                                                                                                                   |
| Business ethics                                           | Gabon scores 28/100 in Corruption Perception Index; Gabon re-applied as EITI member country, yet to be assessed.                                                                                                                                                                                                                                                                  |

Table 16. ESG features of Maboumine project, Gabon

### 3.10.4 Infrastructure assessment

#### Potential Investment Needs:

- Road Infrastructure: Investment potential to improve accessibility to project site (modernise N1 from Bifoun to Lambaréné; ca. US\$ 300,000 per km).
- Renewable Energy Ventures: Harness hydro energy potential (including the establishment of supporting infrastructure and/or a local grid) for the remote project site.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | The Maboumine deposit is located about 35 km east from the town of Lambaréné, in the province of Moyen-Ogooué, that offers infrastructure facilities and access. The polymetallic ore deposit, niobium, rare earths, uranium and thorium, has, since 2005, been developed by Maboumine, a company owned partly by Comilog, a subsidiary of Eramet, (76 %), the Gabonese state (15 %) and other minority shareholders (9 %), under the leadership of Eramet. In 2019 Comilog sold 91.16 % of its stakes in the Maboumine deposit to the Gabonese State. After this transaction, Gabon had to prospect for partners with whom it could relaunch activities on this site, which has been dormant since 2014 in the exploration and mine development phase.                                                                                                                                                                                           |
| Transport                 | Access to the project site from Lambaréné is provided by following the northern route of the N1 national road for 54 km before deviating right for 10 km towards the township of Bindo. Here, a ferry service provides access to Makouké, from which local roads lead an additional 22 km to the project site. The unsealed N1 national road from Lambaréné converts to a highway (sealed road) after 20 km from the turnoff to Bindo at Bifoun. The N1 highway then continues for 164 km northwest to the capital city of Libreville, where goods can be exported. This route furthermore provides access to the nation's only rail infrastructure. Investment potential to improve accessibility to project site (i) modernise N1 from Bifoun to Lambaréné – current financing from the African Development Bank and the government of Gabon - € 88.94m; (ii) construct bridge over the Ogooué river to alleviate the need for ferry transport. |
| Airport                   | Lambaréné Airport is the next available airport. The airport has two runways, a 1,730 m asphalt paved runway and an additional 380 m runway of unpaved overrun on the northeaster end. The airport is used for inland passenger flights, by the military and due to its asphalt surface capable of transporting material and light equipment. The next international airports are Leon M'Ba International Airport (300 km), Port-Gentil International Airport (520 km), and M'Vengue El Hadj Omar Bongo Ondimba International Airport (680 km).                                                                                                                                                                                                                                                                                                                                                                                                   |
| Rail access               | The Trans-Gabon Railway (Transgabonais) is the only railway in Gabon. It runs 670 km east from Owendo port station in Libreville to Franceville via numerous stations, the main ones being Ndjolé, Lopé, Booué, Lastoursville and Moanda. In 2020, the Transgabonais carried 330,000 passengers and 9 million t of goods, including 90 % of the country's manganese production. Since 2015, the rail infrastructure has been undergoing a € 509m modernisation, renovation, and upgrade programme with the aim of restoring the initial transportation capacity. In 2021, the Gabon state contributed an additional € 197m to further increase the capacity of the line to reach 19 million t by 2027. The nearest railway station to the project site is Gare D'oyane, approximately 40 km northwards from the N1-N2 intersection on the N1. The larger Ndjolé station is                                                                        |

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                         |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|------------------------|--------------------|---------|-------------|-------------|------------|-------------|-------------|-----------|----------------|----------------|-----------|-------------|---------------|--------------------------------|------------------------|--------------------|-------------|------------|------------|---------|------|------|-----------------|---|-------------------------|-------------|---------------|----------------|
|                                | the second closest, situated approximately 68 km eastward from the N1-N2 intersection on the N2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                         |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| Port                           | <p>Port facilities for international transport with container terminals are Port Libreville (300 km) and Port Gentil (520 km). Both are served by shipping lines CMA CGM, Maersk, NDS, OTAL, PROTOS, Safmarine. The following table presents an overview of port conditions:</p> <table><tr><td><b>Water Depth</b></td><td><b>Port Libreville</b></td><td><b>Port Gentil</b></td></tr><tr><td>Channel</td><td>11 – 12.2 m</td><td>7.1 – 9.1 m</td></tr><tr><td>Cargo Pier</td><td>7.1 – 9.1 m</td><td>14 – 15.2 m</td></tr><tr><td>Mean Tide</td><td>2 feet (0.6 m)</td><td>8 feet (2.4 m)</td></tr><tr><td>Anchorage</td><td>7.1 – 9.1 m</td><td>20.1 – 21.3 m</td></tr><tr><td><b>Harbour Characteristics</b></td><td><b>Port Libreville</b></td><td><b>Port Gentil</b></td></tr><tr><td>Harbor Size</td><td>Very small</td><td>Very small</td></tr><tr><td>Shelter</td><td>Good</td><td>Fair</td></tr><tr><td>Max Vessel Size</td><td>-</td><td>Over 500 feet in length</td></tr><tr><td>Harbor Type</td><td>River Natural</td><td>Open roadstead</td></tr></table>                                                                                                                                                                | <b>Water Depth</b>      | <b>Port Libreville</b> | <b>Port Gentil</b> | Channel | 11 – 12.2 m | 7.1 – 9.1 m | Cargo Pier | 7.1 – 9.1 m | 14 – 15.2 m | Mean Tide | 2 feet (0.6 m) | 8 feet (2.4 m) | Anchorage | 7.1 – 9.1 m | 20.1 – 21.3 m | <b>Harbour Characteristics</b> | <b>Port Libreville</b> | <b>Port Gentil</b> | Harbor Size | Very small | Very small | Shelter | Good | Fair | Max Vessel Size | - | Over 500 feet in length | Harbor Type | River Natural | Open roadstead |
| <b>Water Depth</b>             | <b>Port Libreville</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Port Gentil</b>      |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| Channel                        | 11 – 12.2 m                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 7.1 – 9.1 m             |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| Cargo Pier                     | 7.1 – 9.1 m                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 14 – 15.2 m             |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| Mean Tide                      | 2 feet (0.6 m)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 8 feet (2.4 m)          |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| Anchorage                      | 7.1 – 9.1 m                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20.1 – 21.3 m           |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| <b>Harbour Characteristics</b> | <b>Port Libreville</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Port Gentil</b>      |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| Harbor Size                    | Very small                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Very small              |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| Shelter                        | Good                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Fair                    |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| Max Vessel Size                | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Over 500 feet in length |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| Harbor Type                    | River Natural                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Open roadstead          |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| Energy                         | The nearest power stations to the project site are in Lambaréné, Bifoun, and Ebel Abanga. All power stations generate less than 10 MW and are sourced by diesel. Power transmission lines in the region are non-existent. Investment opportunities to source energy from existing power stations by means of installing power transmission lines, or to capture renewable potential in the region (hydro and solar) to establish a reliable local grid. This being said, considerations must be made to the local geography, where the dense forest engulfing the project area challenges the viability of spatially consuming installations (e.g., solar farm). As such, studies should prioritise harnessing hydro power from the near-lying Ogooué River and erecting relevant supporting infrastructure.                                                                                                                                                                                                                                                                                                                                                                                                                          |                         |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| GHG emission                   | Currently, around half of the electricity consumed in Gabon comes from hydroelectric generation, largely from the Grand Poubara Hydroelectric Dam (160 MW) and Kinguele Aval Hydroelectric Dam (70 MW). The construction of several photovoltaic power plants has also been launched in a bid to electrify rural provinces, including a 120 MWp solar plant by Solen and eight hybrid solar plants totaling 2.2 MW by Engie. Gabon is considered one of the most carbon-positive countries globally, as tropical forests cover 88 % of its territory and are estimated to absorb four times more carbon dioxide than it produces. Nevertheless, only 2 % of the nation’s vast hydro potential (8,000 MW) has been harnessed, making it a clear contender for Gabon’s energy transition. Furthermore, Gabon averages 300 sunshine days a year, translating into an average daily solar insolation of around 4 kWh/m2. Since Gabon is heavily forested, it presents challenges in connecting communities to the electricity grid, making stand-alone solar systems ideal to power remote areas, e.g., project site. However, this should be weighed up against the costs and effects of land clearing with respect to the project life. |                         |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |
| Water                          | The Maboumine project site is located adjacent to the Ngounié River. Water plan subject to feasibility study, however environmental considerations necessary to guarantee no contamination.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                         |                        |                    |         |             |             |            |             |             |           |                |                |           |             |               |                                |                        |                    |             |            |            |         |      |      |                 |   |                         |             |               |                |

Table 17. Infrastructure assessment of Maboumine project, Gabon

### 3.10.5 Further reading

Eramet S.A. (2017): 2016 Registration Document. <https://www.eramet.com/wp-content/uploads/2023/08/2016-Eramet-Annual-Report-EN.pdf> (accessed: 06.02.2024)

Gabon Review (2022): Gabon: The Maboumine project is looking for a buyer. <https://www.gabonreview.com/gabon-le-projet-maboumine-en-quete-dun-repreneur/> (accessed: 06.02.2024)

Hatch (2023): Maboumine Demonstration Plant 2012-2015. <https://www.hatch.com/Projects/Metals-And-Minerals/Maboumine-Demonstration-Plant> (accessed: 06.02.2024)

Mining Review Africa (2016): Eramet partners with Gabon's state miner to develop world-class polymetallic deposit. <https://www.miningreview.com/magazine-article/eramet-partners-gabons-state-miner-develop-world-class-polymetallic-deposit/> (accessed: 06.02.2024)

Ministry of Mines, Gabonese Republic (2023): Mining sector: update on the revival of the Mabounié project. <https://www.mines.gouv.ga/9-actualites/817-secteur-minier-point-sur-la-relevance-du-projet-mabounie-/> (accessed: 06.02.2024)

Nazari G., Lamotte J., Ries M., Agin J., Tizon E., Kashani-Nejad S., Bellino M. & Krysa B. (2018): Development of a Metallurgical Process for Eramet's Mabounié Nb-REE Project. In: Davis, B., et al. Extraction 2018. The Minerals, Metals & Materials Series. Springer, Cham. [https://doi.org/10.1007/978-3-319-95022-8\\_198](https://doi.org/10.1007/978-3-319-95022-8_198) (accessed: 06.02.2024)

### 3.11 Millie's Reward lithium pegmatite project (Madagascar)

Information as of 01/2024

#### 3.11.1 General project background

|                                    |                                                                                                                                                                                                                                                                            |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Lithium                                                                                                                                                                                                                                                                    |
| <b>Other commodities</b>           | Tantalum, niobium, beryllium                                                                                                                                                                                                                                               |
| <b>Location</b>                    | Vakinankaratra, Madagascar<br>20°03' S, 46°57' E, 1,200 – 1,800 m.a.s.l.                                                                                                                                                                                                   |
| <b>License type</b>                | Exploration permits: PE 11545, PE 39808, PRE 4383<br>(25 km <sup>2</sup> )                                                                                                                                                                                                 |
| <b>License owner / operator</b>    | Greenwing Resources Ltd. (public company)                                                                                                                                                                                                                                  |
| <b>Contact</b>                     | Matisse Tower, Level 21, 110 Mary Street<br>Brisbane, Queensland 4000<br><a href="https://www.greenwingresources.com/millies-reward">https://www.greenwingresources.com/millies-reward</a><br><a href="mailto:info@greenwingresources.com">info@greenwingresources.com</a> |
| <b>Project status</b>              | Target outline, temporarily on hold                                                                                                                                                                                                                                        |
| <b>Possible production by 2030</b> | Unlikely for whole deposit; possibly at small scale                                                                                                                                                                                                                        |

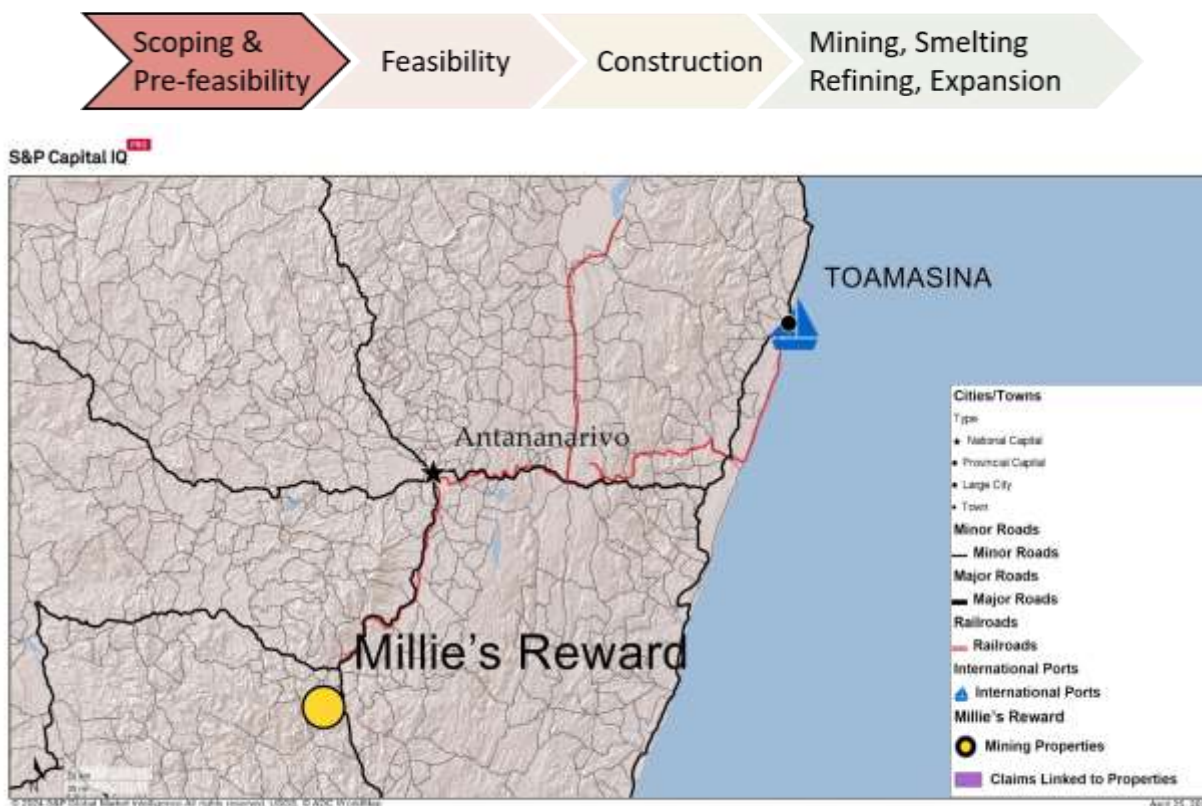


Figure 11. Millie's Reward project location, Madagascar



### 3.11.2 Economic assessment

#### General project background:

The Millie's Reward area hosts numerous pegmatitic dikes, veins, pods and sills, with the highest geochemically evolved pegmatites occurring within dolomitic marbles along the contact between marbles and schists. Most of the pegmatites are artisanally mined for gemstones, and most of the ones in which gemstones do not occur, contain variable quantities of spodumene-hosted lithium. The lithium-bearing pegmatitic dikes are up to 10 m thick and strike up to several hundred metres. To date, over 200 pegmatite surface occurrences have been identified in the project area along a strike length of 10 km. High-grade rock chip samples have returned grades of up to 7.1 % Li<sub>2</sub>O and a 31 m trench sample showed an average grade of 3.7 % Li<sub>2</sub>O. The current owner seeks investment for further exploration focusing on completing the soil sampling program over lithium-bearing pegmatites, commencing pitting and trenching, followed by geophysics to identify potential sub-surface pegmatites. Subsequent steps will include technical studies and in-fill drilling as well as resource estimation and a definitive feasibility study.

#### Project description:

|                                    |                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Pegmatite                                                                                                                                                                                                                                                                                                                                                                             |
| Drilling results                   | Ampatsikahitra: surface occurrence over ~500 m, up to 7.1 % Li <sub>2</sub> O<br>Ilapa: surface occurrence over ~700 m, up to 1.8 % Li <sub>2</sub> O<br>Manjaka: surface occurrence over ~300 m, up to 6.9 % Li <sub>2</sub> O<br>Vietnam: surface occurrence over ~100 m, up to 6.9 % Li <sub>2</sub> O<br>Tsarafara: surface occurrence over ~500 m, up to 4.1 % Li <sub>2</sub> O |
| Trenching results                  | 31 m at 3.72 % Li <sub>2</sub> O                                                                                                                                                                                                                                                                                                                                                      |
| Waste to ore ratio (whole orebody) | Expected to be low due to (sub-)surface location of the pegmatite bodies                                                                                                                                                                                                                                                                                                              |
| Life of mine                       | Currently no information available                                                                                                                                                                                                                                                                                                                                                    |
| Investment required                | Funding for further exploration                                                                                                                                                                                                                                                                                                                                                       |

#### Mining and processing:

- So far, there is no information about mining and processing available. Conventional open pit methods are expected, employing drilling, blasting, and hauling over multiple pegmatite orebodies. The waste to ore ratio will increase as mining progresses into the deeper parts of the ore bodies.
- The company envisages marketing of direct shipping ore or 6 % Li<sub>2</sub>O spodumene concentrate (SC6). Spodumene can be concentrated by crushing, sorting, milling, screening, dense media separation, magnetic separation, spodumene flotation and filtration, but processing does not have to include all steps.



### BGR assessment and comments:

- The company aims to define a high-grade, high-tonnage resource with a long life of mine. The waste to ore ratio is expected to be initially low due the near-face position of the pegmatite bodies. So far, eight high priority prospects have been defined in the project area. The occurrence of over 200 pegmatite surface occurrences over a strike length of 10 km holds additional potential for an increase of resources.
- With lithium as the only commodity, the project would face difficulties to profitably extract the complete resource when lithium prices decline. At the beginning, the waste to ore ratio is low, and hence production costs are lower. Production costs will increase with time as the waste to ore ratio increases. In addition to lithium, elevated levels of beryllium, niobium and tantalum were also found in the drill samples. If these results are confirmed during resource and reserve development, it is recommended to additionally extract these commodities, if economically viable, in order to position the project more broadly against future market fluctuations.
- In December 2017, Greenwing acquired the Millie's Reward project from Ruby-Red Madagascar S.A.R.L. Greenwing will pay to the vendor (Ruby-Red Madagascar S.A.R.L.) a 0.25 % sales royalty on any future lithium product from Millie's Reward for a period of 12 years from the first sale or up to US\$ 2m.
- Millie's Reward is located ~175 km south of the capital of Antananarivo and ~30 km south of Antsirabe (~270,000 inhabitants). The project is accessed via the RN7 paved highway connecting Antananarivo and Antsirabe. The port of Toamasina is accessed via road and rail within ~515 km. The project is still at an early stage. There is a limestone quarry ~4 km east of the site and the project could benefit from its infrastructure and minimise roadworks for heavy machinery and materials. Furthermore, no information can yet be provided on electricity and water supply.

### 3.11.3 ESG assessment

As the project is still at an early stage, information on various ESG categories and management is not yet available. It is expected that the company will provide test results on certain ESG aspects and a mine closure plan as part of the (pre)feasibility studies for the development of the project, similar to its Graphmada project. To date, no ESG issue has been identified that could not be resolved through diligent management and best practices.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Environmental management                                           | No reports on incidents found. No information on environmental management issues available.                                                                                                                                                                                                                                                                                                                                                        |
| Efficient use of energy, renewable energy, GHG emissions reporting | There is currently no information on the planned power supply. In 2020, 87 % of installed electricity generation was from renewables (bioenergy; IRENA 2022)                                                                                                                                                                                                                                                                                       |
| Water management and consumption                                   | Water stress in the area is considered to be low; maximum precipitation in January with 300 mm and the driest conditions in September with 9 mm. The company does not provide information on water supply. Potential for heavy rainfall events, however low riverine flood risk                                                                                                                                                                    |
| Pollution prevention                                               | No specific information on AMD potential available but considered to be low because of buffering from dolomitic marble. No specific information on U and Th contents available yet. If the company intends to use flotation technology, this may involve the use of hazardous reagents.                                                                                                                                                            |
| Air quality                                                        | Proximity to settlements (~12 km to the villages of Manandona) will require dust suppression measures (e.g. sprinkling of roadways and TSF).                                                                                                                                                                                                                                                                                                       |
| Tailings management                                                | There is currently no information on reserves or resources, nor on planned annual production. Accordingly, the size of a TSF cannot yet be estimated. No information on management standards available.                                                                                                                                                                                                                                            |
| Waste management                                                   | There is currently no information available on the planned waste management.                                                                                                                                                                                                                                                                                                                                                                       |
| Hazardous materials management                                     | No relevant information available for review at this stage.                                                                                                                                                                                                                                                                                                                                                                                        |
| Noise and vibration                                                | The impact depends on the distance to the settlements after potential resettlement (~12 km to the villages of Manandona), although the risks are estimated to be low with diligent operation.                                                                                                                                                                                                                                                      |
| Protected areas and biodiversity                                   | The project site is not located in, but close (1-2 km) to the Ibity national park Key Biodiversity Area. Respective management measures to mitigate impacts likely needed.                                                                                                                                                                                                                                                                         |
| Mine closure                                                       | No detailed information on mine closure available for review at this stage.                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Social and socio-economic issues</b>                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Community health, safety and security                              | The mine site is located ~12 km west of Manandona (~15,000 inhabitants, but constituted by 11 villages; as of 2015) and ~30 km south of Antsirabe (265,000 inhabitants; 2018 census), which are classified as rural cluster and urban centre, respectively. The project area is sparsely settled. Agriculture extends right up to the outcropping pegmatite site. Potential negative impacts on local communities are generally considered as low. |
| Dialogue and engagement with communities and stakeholders          | The company has initiated a community engagement programme to demonstrate to the community the benefits of developing a significant project in the region. The community programme will be largely based on the Graphmada Care Programme, which was recognised as the leading programme of its kind in Madagascar in 2018. In the northern part of the project area there is a small underground tunnel that has been exploited                    |

| ESG category                                  | Assessment                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                               | by artisanal miners for its gemstone potential since the early 2000s. Engagement with ASM miners probably relevant.                                                                                                                                                                                                                                |
| Land acquisition and involuntary resettlement | No detailed information on the company's resettlement policy available. Remediation from impact on agricultural activities probably needed. The project site is not close to any cultural heritage site.                                                                                                                                           |
| Occupational health & safety management       | No information on OHS management practice available. No records of health and safety incidents available. Project is located in dengue and malaria region.                                                                                                                                                                                         |
| Workers' rights                               | Madagascar scores 65/100 in the Labour Rights Index. No information on specific workers' rights situation at the companies' operations available for review.                                                                                                                                                                                       |
| Gender and diversity                          | The Company intends to consider the recommendations and guidance in the ASX Corporate Governance Council's Principles and Recommendations. However, the Diversity Policy is not part of an employee's contract of employment with the Company and does not give rise to any contractual obligations.                                               |
| Local value added and community development   | There is no information on local value addition and community development available. Company tax rate is 20 % and a royalty of 4 % is applied to lithium sales. The implementation of the new mining code provides for the creation of an investment fund for social and communal mining based on a contribution of 3 % of the CAPEX of a project. |
| <b>Governance</b>                             |                                                                                                                                                                                                                                                                                                                                                    |
| Legal compliance                              | Exploration permits for PE 11545, PE 39808, PRE 4383 (25 km <sup>2</sup> ). No indication of any violation of the law found.                                                                                                                                                                                                                       |
| Management practices                          | Corporate governance policies on company level available, but very limited information on management practices, evidence of practice on mine site is not yet available.                                                                                                                                                                            |
| Transparency and reporting                    | Listed on ASX; information for investors, reports on financial accounts and shareholder structure available.                                                                                                                                                                                                                                       |
| Business ethics                               | Greenwing has some general ethics policies (e.g. code of conduct) available online on its investors section, however no information on management practices. Madagascar scores 25/100 in the Corruption perception Index; Madagascar is an EITI country.                                                                                           |

Table 18. ESG features of the Millie's Reward project, Madagascar

### 3.11.4 Further reading

Bass Metals Ltd. (2017): Bass completes acquisition of the highly prospective Millie's Reward Lithium Project.

<https://announcements.asx.com.au/asxpdf/20171212/pdf/43q2prdh2pv2x.pdf> (accessed: 11.01.2024)

Bass Metals Ltd. (2018a): Millie's Reward lithium project - Investor and analyst site visit, May 2018.

<https://hotcopper.com.au/documentdownload?id=uOMxKKzFkiWRTLKhOROKAxjvTDYC6w29zxeZouR0ke92GA%3D%3D> (accessed: 11.01.2024)

Bass Metals Ltd. (2018b): Bass Metals Ltd delivers outstanding high grade channel sample intersection of 31 metres at 3.72% Lithium Oxide (Li<sub>2</sub>O) at its 100% owned Millie's Reward Project. <https://hotcopper.com.au/threads/ann-bsms-outstanding-lithium-intersection-of-31m-at-3-72.4423154/> (accessed: 11.01.2024)

Greenwing Resources (2023a): Investor presentation.

[https://static1.squarespace.com/static/60f8ecc12612757791887849/t/64ac90bf8824c05fd7cb0150/1689030871967/2023+07+11\\_Investor+Presentation\\_GW1.pdf](https://static1.squarespace.com/static/60f8ecc12612757791887849/t/64ac90bf8824c05fd7cb0150/1689030871967/2023+07+11_Investor+Presentation_GW1.pdf) (accessed: 11.01.2024)

Greenwing Resources (2023b): Madagascar update.

<https://wcsecure.weblink.com.au/pdf/GW1/02730368.pdf> (accessed: 11.01.2024)

International Renewable Energy Agency IRENA (2022). Renewable Energy Statistics 2022.

[https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jul/IRENA\\_Renewable\\_energy\\_statistics\\_2022.pdf?rev=8e3c22a36f964fa2ad8a50e0b4437870](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jul/IRENA_Renewable_energy_statistics_2022.pdf?rev=8e3c22a36f964fa2ad8a50e0b4437870)

### 3.12 Monte Muambe REE carbonatite project (Mozambique)

Information as of 01/2024

#### 3.12.1 General project background

|                                    |                                                                                                                                                        |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | REE                                                                                                                                                    |
| <b>Location</b>                    | Tete Province, Mozambique<br>16°19' S, 34°06' E, 500 – 600 m.a.s.l.                                                                                    |
| <b>License type</b>                | Prospecting Licence LPP7573L (39.4 km <sup>2</sup> ), valid until 22.05.2025. Mining Concession in application.                                        |
| <b>License owner / operator</b>    | 51 % Altona Rare Earth Plc. with the option to acquire 70 % after presentation of feasibility study), rest: Ussokoti Investimentos SU.                 |
| <b>Contact</b>                     | Eccleston Yards, 25 Eccleston Place, London, England, SW1W9NF                                                                                          |
| Direct contact established: No     | <a href="https://www.altonare.com/">https://www.altonare.com/</a><br><a href="https://www.altonare.com/contact/">https://www.altonare.com/contact/</a> |
| <b>Project status</b>              | Scoping study                                                                                                                                          |
| <b>Possible production by 2030</b> | At best by 2028, but prefeasibility and feasibility study still to be completed                                                                        |

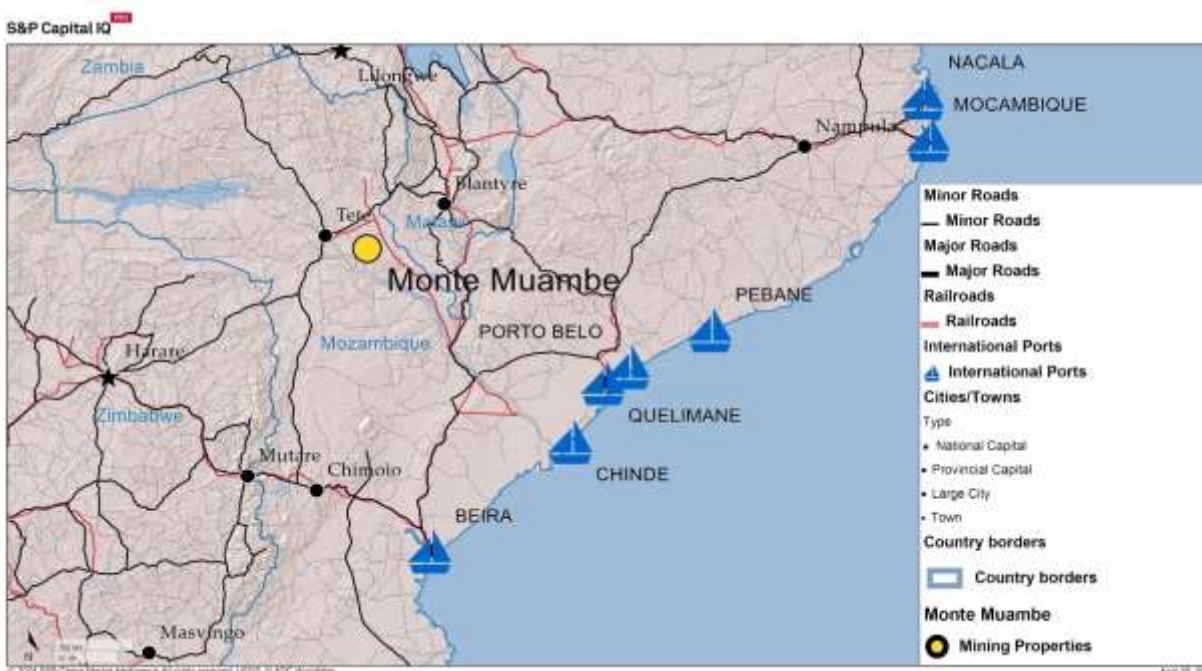


Figure 12. Monte Muambe project location, Mozambique

### 3.12.2 Economic assessment

#### General project background:

Monte Muambe is located in the central part of the Karoo Moatize-Minjova coal basin. It is located around 50 km east of the Provincial capital Tete, which is the centre of coal mining in Mozambique. The carbonatite intrusion is hosted by Upper Karoo Sandstones. The age of the intrusion is presently unknown. The Monte Muambe structure resembles a ring-dyke. The central basin formed by the inner part of the structure predominantly consists of fenites, various types of carbonatites, breccias, as well as pyroclastic rocks. The inner diameter of the carbonatite intrusion at surface level is about 3.3 km. The present erosion level might correspond to the roof of the carbonatite intrusion, immediately under the base of the volcanic top.

Initial exploration work at Monte Muambe took place in the early 1960s. Work done by the Bulgargeomin brigade in 1983 focused on fluorite occurrences. In 2017, Ussokoti Investimentos Sociedade Unipessoal, a Mozambican company, secured the Licence, and carried out limited exploration for rare earths and guano. In 2021 Altona Rare Earths entered into an agreement to acquire 70 % of the project and is holding an exploration license until 2025 only. Besides exploration rights, the licence gives the licensee a preferential right to an application for a Mining Concession valid for up to 25 years. Projected start for mining and processing is in 2029.

#### Project description:

|                                    |                                                                                                                                                                          |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Carbonatite                                                                                                                                                              |
| JORC compliant resources           | 13.6 Mt @ 2.42 % TREO (cut-off TREO 1.5 %; 894 ppm Pr <sub>6</sub> O <sub>11</sub> , 2,230 ppm Nd <sub>2</sub> O <sub>3</sub> , 102 ppm Dy <sub>2</sub> O <sub>3</sub> ) |
| Waste to ore ratio (whole orebody) | 1.67                                                                                                                                                                     |
| Annual production                  | 750,000 t of ore, 15,000 t Mixed Rare Earth Carbonate (MREC).<br>Recovery to concentrate 60 %, recovery to MREC product 80 %.<br>Total recovery to MREC 48 %.            |
| Life of mine                       | 18 years                                                                                                                                                                 |
| Investment required                | US\$ 276m for start of mine and processing plant                                                                                                                         |
| Net present value (NPV)            | US\$ 283m (8 % discount rate), IRR 25 %                                                                                                                                  |
| Share of global REE production     | 3.1 % ( <i>USGS estimate global REE production of 280,000 t</i> )                                                                                                        |
| Value addition potential           | No REE refinery in Mozambique; concentrates are supposed to be further processed to MREC                                                                                 |

#### Mining and processing:

- The mining method is based on conventional open pit technology using truck and shovel, and drill and blast for hard rock. The ore is hauled to a Run of Mine (ROM) stockpile. All mine waste will be hauled directly from the pit and placed onto a designated location. Parts of the waste rock will be used as construction material for the TSF dam. Contract-mining is selected as the operating strategy at the Project.

- The recovery process flow sheet comprises a two-stage selective hydrochloric acid leach process. The first stage being a calcite gangue leach in a weak (pH 4) acid solution and the second stage being a strong acid leach (20% HCl) at ~80°C. The hydrochloric acid is recycled via calcium sulphate precipitation with sulphuric acid, which is produced on site via a commercial sulphur burner plant. The process flow sheet also includes purification and Mixed Rare Earth Carbonate (MREC) precipitation.

### **BGR assessment and comments:**

- The scoping study is the very first economic assessment and has high uncertainties concerning economics and resources. The study reports an accuracy of OPEX of +35 % and -30 %. Mineral beneficiation (22 %) and hydrometallurgical plant (52 %) account for almost 75 % of total OPEX.
- The deposit is a light REE dominated medium-grade, medium-tonnage operation with a relatively low waste to ore ratio of 2.6. The relatively long life of mine (20 years) can be positive for the development of the region. Resource expansions are possible due to additional anomalies that have not yet been tested by drilling.
- Mining is considered low-risk. The recovery of REO from the ore to the concentrate is only 60 % according to the Scoping Study. This might be related to a conservative approach of the operator, or difficulties in the production of the concentrate and thus present a severe risk for the project economics.
- Ore processing in Mozambique and the general possibility of producing a concentrate usually is of relatively low risk. Further processing to a mixed REE carbonate product might be more challenging, as chemicals and supplies will have to be imported to Mozambique and a steady supply chain including customs has to be assured.
- Project revenues and NPV are based on Adamas Intelligence price forecasts for the individual critical magnet REEs, and the magnet REEs (Nd, Pr, Tb and Dy), which account for the total REE revenues (Nd and Pr for 86 % and Dy and Tb for 14 %). The average NdPrO price for the last 5 years is ~US\$ 125,000/t, albeit with strong fluctuations. By comparison, the average NdPrO price used in the Monte Muambe project financial model is US\$ 134,000/t up to 2030 and US\$ 187,000 to 2040. These assumptions pose a high risk. Not only to the NPV, but also on the financial viability.
- The mine site is located 50 km ESE of the provincial Capital Tete, which is the centre of coal mining in Mozambique with multi million tonnes of coal handling per year. Infrastructure from the main ports like Beira or Nacala to Tete is very good with roads and railroad. The last kilometres into the mining are a poorly developed and need upgrade for construction and mining.



### 3.12.3 ESG assessment

The level of publicly available project information is good. No major ESG issues were identified that would preclude responsible investment. The operator documents its corporate policies, information on management systems is limited due to the early stage of the project. Environmental risks are considered to be low, although water management in the arid environment may be challenging. Stakeholder engagement and OHS management is widely in place, as are CSR measures. The operator rates its own OHS performance in 2022 as unsatisfactory and is investigating improvement measures. Possibly contentious issues concern worker remuneration and illegal ASM on the site.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Environmental Management                                           | EMP for exploration. The Company's activities were subjected to an independent Environmental Audit, which was validated by a National Agency of Tete Province (2022). EMP for proposed mining operations planned as well as Level A EIA as part of the mining concession application.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Efficient use of energy, renewable energy, GHG emissions reporting | Electrical power during construction and commissioning from diesel generators and solar PV. During construction 18 MW electrical power maximum demand provided by a hybrid power generation plant, which will comprise a backup diesel-powered electrical generator station and solar PV, supported by a battery energy storage system. Solar PV to contribute approximately 25% to the overall generation. During production connected to the grid, which is hydropower dominated (82 %).                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Water management and consumption                                   | A bore well-field proposed as best option for water supply. Groundwater has a high total dissolved solids load (about 1,000 mg/l) which will require water treatment prior to use in the plant and as potable water. Distance to the Zambezi river is approximately 30 km as the crow flies. This may be considered as a possible extraction source in the future. Dewatering the open pit could also be a source of water during increased LOM. There is a dry season from April to October and a rainy season from December to March. The water stress is moderate, riverine flood risk in the area is extremely high (Aquaeduct Water Risk Atlas). Adequate stormwater management is required. Leachate is collected in the finger drains and flows into a dirty water evaporation pond. An overflow pipe that is connected to a sewerage line returning to the treatment plant is integrated into the pond to manage excessive runoff. |
| Pollution prevention                                               | Low acid generation potential of tailings and carbonate containing host rock. Relatively low U and Th content for a carbonatite deposit. Concentrates will not fall into the class VII category. Treatment of bleed stream of leached concentrates unclear at this stage of the project. Radionuclides (Th, U and the decay nuclides) will be removed during the hydrometallurgy refining stage to produce a radionuclides-free MREC. Leaching residues are planned to be deposited in the TSF (at this stage of the project).                                                                                                                                                                                                                                                                                                                                                                                                             |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Air quality                                               | Scarcely populated area. A conceptual site block plan locates the main accommodation camp outside of the crater to minimize dust, noise and radiation exposure. Dust suppression during mining already planned in the scoping study.                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Tailings management                                       | The mine waste will be stored in a full-containment facility in line with the Global Industry Standards for Tailings Management. The tailings will be placed on a 2 mm high-density polyethylene lined facility with suitably constructed under-drainage.<br>Part of the hydrometallurgical plant waste will contain residual thorium and other radioactive elements, which will require safe disposal in the TSF. The required tailings dam size is calculated to 11.61 Mt for the beneficiation plant and to 1.66 Mt for the hydrometallurgical plant waste product. The scoping study suggests a “radionuclide deportment study” in the prefeasibility study. |
| Waste management                                          | A general landfill site of approximately 14,500 m <sup>2</sup> is envisaged complying with Class C landfill criteria (subject to confirmation of hazardous waste classification) with respective barrier systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Hazardous materials management                            | Laboratory waste, oil and fuels, medical waste and radioactive waste are separated and allocated to dedicated areas at a salvage yard for recycling and disposal off site, or incinerated on site.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Noise and vibration                                       | No information, besides that diesel generator units are planned to be housed in acoustic containers and located in a section of the beneficiation plant that can be bermed off to isolate noise from the general plant site. Main accommodation camp outside of the crater to minimize dust, noise and radiation exposure.                                                                                                                                                                                                                                                                                                                                       |
| Protected areas and biodiversity                          | The project is not located in or close to a key biodiversity area and there are no environmentally protected areas within the license area.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Mine closure                                              | Provision must be made for an environmental bond to cover rehabilitation activities during the closure of the mine. The bond may take the form of an insurance policy, a bank guarantee, or a deposit in cash in a bank account provided by MIREME. The value of the bond is set by MIREME and reviewed every two years. No information available at this stage.                                                                                                                                                                                                                                                                                                 |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Community health, safety and security                     | No information available at this stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Dialogue and engagement with communities and stakeholders | Comprehensive stakeholder consultation at national, regional, and local levels will be undertaken during the ESIA, and will be conducted by a combination of Mozambican specialists, technical advisors, and Altona personnel. Stakeholder consultation activities included stakeholder interviews, focus group discussions, community mapping, and public meetings. The focus during the ESIA will be on the Project’s potential impacts and appropriate mitigation and management.                                                                                                                                                                             |
| Land acquisition and involuntary resettlement             | There are no human settlements inside the project’s licence, nor visible subsistence farming activities (based on aerial images). It is therefore expected that the Project will not involve any resettlement, or loss of                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| ESG category                                | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | subsistence land. Traditional activities such as honey harvesting currently occurring at Monte Muambe will be able to continue outside of actual mining areas, which will cover only a part of Monte Muambe.                                                                                                                                                                                                                                             |
| Occupational health & safety management     | No information available at this stage                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Workers' rights                             | Mozambique scores 71.5/100 in the Labour Rights Index, meaning reasonable access to decent work. No information on workers policy available at this stage.                                                                                                                                                                                                                                                                                               |
| Gender and diversity                        | Commitment to gender and diversity policy. No further information available at this stage. .                                                                                                                                                                                                                                                                                                                                                             |
| Local value added and community development | Neighbouring communities are already involved in the Project, mostly through employment of non-skilled labour. The Company will implement a CSR programme from the PFS stage, and an education programme to ensure that as many community members as possible can access employment, including for skilled positions, as well as business opportunities arising from the Project. The company plans to source “locally”, to reduce the carbon footprint. |
| <b>Governance</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Legal compliance                            | No indication of any breaches of law found. Prospecting Licence LPP7573L (39.4 km <sup>2</sup> ), valid until 22.05.2025. Mining Concession in application.                                                                                                                                                                                                                                                                                              |
| Management practices                        | 10 policy principles listed on company website. Company has adopted “Quoted Companies Alliance Corporate Governance Code 2018 (‘the QCA Code’). No international certifications at this early stage of the project. Planned for prefeasibility study.                                                                                                                                                                                                    |
| Transparency and reporting                  | Listed at the London Stock Exchange Annual report and financial statement and information for investors available online.                                                                                                                                                                                                                                                                                                                                |
| Business ethics                             | Mozambique scores 25/100 in the corruption perception index, ranking 145 of 180 countries; Mozambique is an EITI country, but the main issue of the reporting is the quality of the data presented; no indication of unethical practices of the company found.                                                                                                                                                                                           |

Table 19. ESG features of the Monte Muambe project, Mozambique

### 3.12.4 Further reading

Snowden Optiro (2023): Scoping Study about the Monte Muambe project. <https://wp-altona-2021.s3.eu-west-2.amazonaws.com/media/2023/10/Altona-Rare-Earths-Plc-CPR-and-Scoping-Study-18-October-23.pdf> (accessed 22.01.2024)

### 3.13 Musongati Ni (-Co-Cu-PGE) laterite project (Burundi)

Information as of 06/2023

#### 3.13.1 General project background

|                                    |                                                                                                                                                                                                                                                       |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Nickel                                                                                                                                                                                                                                                |
| <b>Other commodities</b>           | Cobalt, copper, platinum                                                                                                                                                                                                                              |
| <b>Location</b>                    | Rutana Region, Burundi<br>3°42' S, 30°5' E, ~1,700 m.a.s.l.                                                                                                                                                                                           |
| <b>License type</b>                | Exploration license (170 km <sup>2</sup> as of 2011)                                                                                                                                                                                                  |
| <b>License owner / operator</b>    | Currently state-owned (Tendering procedure to domestic and/or foreign consortia in progress)                                                                                                                                                          |
| <b>Contact</b>                     | Ministry of Hydraulics, Energy and Mines (OBM)<br>Direct contact established: No<br>Rohero I, Avenue de la Revolution N°7<br>745 Bujumbura, Burundi<br><a href="http://www.obm.bi">www.obm.bi</a><br><a href="mailto:obm@gmail.com">obm@gmail.com</a> |
| <b>Project status</b>              | Inactive; old feasibility study available (2011)                                                                                                                                                                                                      |
| <b>Possible production by 2030</b> | unlikely                                                                                                                                                                                                                                              |

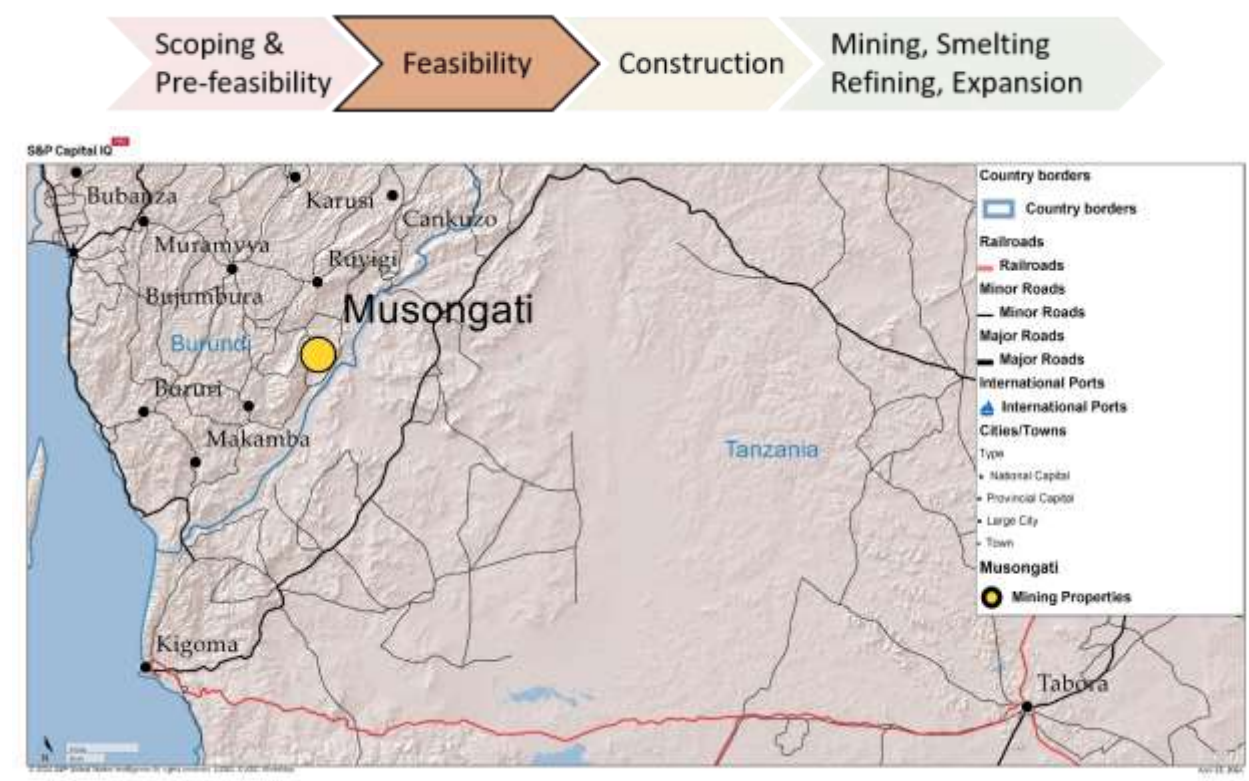


Figure 13. Musongati project location, Burundi

### 3.13.2 Economic assessment

#### General project background:

Nickel laterites at Musongati were discovered in 1972 through a joint exploration program of the Burundi government and the United Nations Development Program. The Musongati Ni(-Co-Cu)-laterite is hosted by a series of layered ultramafic to mafic complexes occurring within the Kabanga-Musongati Belt of Central Africa. The ore bodies comprise three zones, namely Buhinda, Rubara and Geyuka. Each zone includes both mineralised iron-rich ferralite and rather magnesium-rich saprolite horizons. Nickel and cobalt are present in both horizons, with higher grades found in the saprolite. Precious metals, including platinum, palladium, and gold, occur in the ferralite and canga (between ferralite and saprolite) layers. In 03/2023 the Burundian government sought interest from experienced consortiums for the development of Musongati. A feasibility study carried out in 2011 provides potential economic data for the project considering different options like direct export of ore or various ore processing scenarios.

#### Project description:

|                                   |                                                                                                                                                                                                                                                    |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                  | Ni(-Co-Cu)-Laterite                                                                                                                                                                                                                                |
| JORC compliant resources          | 150 Mt @ 1.31 % Ni, 0.09 % Co, 0.21 % Cu                                                                                                                                                                                                           |
| Share of global nickel resources  | 0.66 % ( <i>USGS estimate global Ni resources of 300 Mt</i> )                                                                                                                                                                                      |
| Share of global cobalt resources  | 0.53 % ( <i>USGS estimate global Co resources of 25 Mt</i> )                                                                                                                                                                                       |
| Share of global copper resources  | 0.02 % ( <i>USGS estimate global Cu resources of 2,100 Mt</i> )                                                                                                                                                                                    |
| Waste to ore ratio                | 2.9 (for the first 6 years of mining)<br>( <i>BGR estimate based on the mining plan in the BFS (2011)</i> )                                                                                                                                        |
| Annual production                 | Up to 25 kt of contained Ni                                                                                                                                                                                                                        |
| Life of mine                      | >25 years                                                                                                                                                                                                                                          |
| Investment required               | Depending on the processing option, an old feasibility study includes different CAPEX scenarios, ranging between US\$ 125m and US\$ 1.1bn (in 2011).                                                                                               |
| Net present value (NPV)           | <US\$ 523,000 for all scenarios (assuming long-term nickel prices of US\$ 26,460/t and 7.5 % discount rate)                                                                                                                                        |
| Share of global nickel production | 0.76 % ( <i>USGS estimate global Ni production of 3.3 Mt</i> )                                                                                                                                                                                     |
| Value addition potential          | Possible upgrades to the mining infrastructure like a railway link to Uvinza (Tanzania) and massive upgrades of the national power supply would improve the general standard of living, but also the national trade, manufactures and agriculture. |

#### Mining and processing:

- Excavation of the overburden and ore will be free dig. Mining will consist of a pre-strip to expose the saprolite ore and then conventional bench mining of soil, ferralite, canga and saprolite. The overburden will be stockpiled for backfilling and rehabilitation. Saprolite and ferralites ores are planned to be mined separately. Whether the ores are blended in the next step or processed separately depends on the selected processing method. For pyrometallurgical process options the mined ore has to be dried to <5 % moisture and then crushed and ground.

- Results of the BFS (2011) show that the size of the nickel resources within the Musongati permit area is sufficient to support an operation producing 25,000 t Ni/a in excess of 25 years. The BFS provides suggestions (including capital and operational cost estimates) for possible further nickel ore treatment and related processing plants, including direct export of ore, heap leaching (of saprolite only or blended ore) and smelting (of saprolite only). However, the cost estimates of the BFS of 2011 are of course outdated and need to be updated.

### **BGR assessment and comments:**

- Musongati is a high-grade, high-tonnage deposit with a relatively low waste to ore ratio of 2.9. The expected long life of mine (25 years) would significantly support long-term employment of the regional mining-related labour force.
- The BFS (2011) assumes relatively high long-term nickel prices of US\$ 26,460/t. This price assumption is highly sensitive to the profitability of the project. Although the nickel price reached a peak of US\$ 25,833/t in 2022, the average price within the last 5 years has been US\$ 17,022/t. It should be noted that the economic assessment from the BFS 2011 (including all mentioned processing options) shows that Musongati is economically unviable considering a discount rate of at least 7.5 % and current nickel prices, but also nickel prices used in the BFS (2011) resulted in a low NPV. Updated studies, including the consideration of copper and cobalt, are essential for the accurate evaluation of Musongati's economic potential. These studies should also consider the optimal treatment of both saprolite and ferrallite ores.
- A new concept for the product options of Musongati should be developed taking into account the market developments of battery raw materials. This could include the production of Ni- and Co-sulphate. Also, the increase of the production capacity should be considered in a new concept for Musongati. There could be synergies with a potential development of the Kabanga nickel project in Tanzania.



### 3.13.3 ESG assessment

The assessment is based on a BFS from 2011 and the Burundian government is currently in search for an operator. Thus proposed mining and processing are probably subject to change and information management practice of a potential owner not available yet. Heap leaching and smelting as processing options from the BFS and were considered in this ESG assessment. Several major human rights violation have been reported for Burundi in the recent past, Burundi had been classified as Conflict-Affected and High Risk Area (see EU 2023).

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                     |
| Environmental management                                           | Operator not yet known; no information on management practices.                                                                                                                                                                                                                                                                                                     |
| Efficient use of energy, renewable energy, GHG emissions reporting | Current power supply not sufficient for development of the project; development of hydropower capacities had been considered for the project (BFS 2011); an alternative option from BFS of a peat fired power station would result in high CO <sub>2</sub> emissions; drying of the ore requires kiln, in the BFS also intended with peat as fuel.                  |
| Water management and consumption                                   | Humid area with low water stress; 1300 mm precipitation mostly in wet season November to March; stormwater control necessary. The BFS states due to high moisture content of the ore no additional extraction of process water needed; at least in the case of heap leaching this appears not conclusive; however, competition in water use is not likely to occur. |
| Pollution prevention                                               | Leaching implies the use of hazardous substances (e.g. sulphuric acid) to release the metals from the ore minerals; adequate measures to prevent spilling are mandatory. In case of smelting, emissions from the smelting process need adequate control. The slags are probably inert, however, their safe deposition has to be ensured.                            |
| Air quality                                                        | Conventional drilling and blasting operation; distance to settlements appears sufficient to be considered low risk. Smelting operation would require dust filter to prevent release of pollutants to the air; considered state of the art.                                                                                                                          |
| Tailings management                                                | Process tailings are only produced in case of high pressure leaching which was not part of this assessment; all disposal facilities should be designed and maintained according to international standards.                                                                                                                                                         |
| Waste management                                                   | Mine waste disposal requires adequate remediation of the waste dumps to guarantee that no pollutants are released to the environment; in case of leaching, neutralisation of heap leach waste or tailings is required.                                                                                                                                              |
| Hazardous materials management                                     | Leaching operations require measures to prevent spill of leaching solution in order to protect ground and surface water. In case of heap leaching the base of leach pads have to be sealed off by a liner system. This system should be capable of handling rainfall events during the wet season.                                                                  |
| Noise and vibration                                                | Conventional drilling and blasting operation; distance to settlements appears sufficient to be considered low risk.                                                                                                                                                                                                                                                 |
| Protected areas and biodiversity                                   | Location is dominantly savannah with marshes along streams, providing a relatively rare habitat; the BFS stated it as unlikely that the planned mining                                                                                                                                                                                                              |



| ESG category                                                                                             | Assessment                                                                                                                                                                                                                                                                                                                       |
|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                          | approach will have lasting negative effects on the local fauna; a detailed assessment of local flora and fauna was not part of the BSF.                                                                                                                                                                                          |
| Mine closure                                                                                             | An initial removal of the top soil and storage with preservation of ecologic functionality for progressive rehabilitation was considered in the BFS; this principle is state of the art.                                                                                                                                         |
| <b>Social and socio-economic issues</b>                                                                  |                                                                                                                                                                                                                                                                                                                                  |
| Community health, safety and security                                                                    | Scarcely populated area; Project site in the vicinity of the town of Musongati (~53,000 inhabitants in the community); distance to settlements large enough that the potential negative impact on the local population is considered low.                                                                                        |
| Dialogue and engagement with communities and stakeholders                                                | Operator not yet known; no information on management practices.                                                                                                                                                                                                                                                                  |
| Land acquisition and involuntary resettlement                                                            | Majority of local population working as subsistence farmer with traditional land tenure; adequate compensation for occupied land from mining activities necessary to secure livelihoods.                                                                                                                                         |
| Occupational health & safety management                                                                  | Operator not yet known; no information on management practices.                                                                                                                                                                                                                                                                  |
| Workers' rights        | Burundi scores 72/100 in the Labour Rights Index. Reported human rights violations for Burundi including forced and child labour (see EU 2023).                                                                                                                                                                                  |
| Gender and diversity  | Reported human rights violation for Burundi including gender-based and sexual violence (see EU 2023).                                                                                                                                                                                                                            |
| Local value added and community development                                                              | Regional economy dominated by subsistence farming; the BFS claims the Musongati deposit to be the only economically usable natural resource on a larger scale in the region. Necessary energy and transportation infrastructure as well as provision of qualified jobs would create significant community development potential. |
| <b>Governance</b>                                                                                        |                                                                                                                                                                                                                                                                                                                                  |
| Legal compliance                                                                                         | Long delay in project development and revocation of licensing in the past suggesting difficult business environment.                                                                                                                                                                                                             |
| Management practices                                                                                     | Operator not yet known; no information on management practices.                                                                                                                                                                                                                                                                  |
| Transparency and reporting                                                                               | Operator not yet known; no information on management practices.                                                                                                                                                                                                                                                                  |
| Business ethics       | Burundi is on the EU list of Conflict-Affected and High-Risk Areas (CAHRA); Burundi scores 20/100 in the Corruption Perceptions Index 2022 (Rank 162/180). Burundi is formally committed to implement the EITI Standard.                                                                                                         |

Table 20. ESG features of Musongati project, Burundi

### 3.13.4 Infrastructure assessment

#### Potential Investment Needs:

- **Road Infrastructure:** Improvement of existing gravel roads accessing the site might be required at estimated costs of US\$ 10 m. Given the potentially long lead-in to any construction work, a mining and processing operation at Musongati would need to rely, initially at least, on road transport. A licence regarding the use, upgrade and ongoing maintenance of the route from Dar es Salaam to Musongati should be acquired with the governments of Burundi and Tanzania, and also the East African Community (EAC).
- **Railway:** There is no domestic railway system in Burundi. Currently, there is a project, by Tanzania Railways, in the pipeline planned to link Tanzania and Burundi. A strategic linkage, by rail sliding, to the main railway from the operation site might be required at estimated costs of US\$ 50m.
- **Renewable Energy Ventures:** Given that the site does not have power grid lines, power supply will be required. Investments in renewable energy, like solar and wind energy, to reduce CO<sub>2</sub> emissions is advised. To cover 80 MW via hydropower will be cost US\$ 171m.
- **Water Supply:** Investments are required on the design and building of water storage facilities in the pit and tailings dams, which will be used to capture rainwater for supply.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | The Musongati Permit Area and proposed mine site lies some 65 km from the town of Gitega, a regional centre with some 120,000 inhabitants. The nearest village to the permit Area is Musongati, which is located along a gravel access road some 5 km to the south of the deposit. Additional capital costs will be the establishment of housing, site roads, offices and associated infrastructure amounting to about US\$ 27m. According to the Vision Burundi 2025, Burundi, in co-operation with the other countries of the EAC and within the framework of the CEPGL and the COMESA, will improve considerably its network of roads, reinforce Lake Tanyaka, and modernize and reinforce its airports |
| Transport                 | Burundi, together with Tanzania, Kenya, Uganda and Rwanda, is a member of the EAC. Burundi is landlocked and relies on transport links through these neighbouring countries for access to both regional and international markets. Basic food supplies, petrol and diesel are available at Musongati village. The Musongati site is characterized by gravel road. Access roads to site are estimated to be upgraded at a cost of US\$ 10m.                                                                                                                                                                                                                                                                 |
| Airport                   | There are a major airport (medium) and two small airports in Burundi, the Gitega Airport, the Melchior Ndadaye International Airport (medium airport), and the Kirundo Airport. The Gitega Airport is about 82 km NE from Musongati, the Melchior Ndadaye International Airport is about 125 km NW from Musongati and the Kirundo Airport about 220 km N of the Musongati site. The modernisation of the Melchior Ndadaye International Airport is supported by China, where the main work involves the modernization of infrastructure and administration facilities and the supply of equipment for air traffic control and meteorology.                                                                 |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rail access  | The nearest railhead is at Kigoma, south of Musongati in Tanzania. The existing railway line from Dar es Salaam to Uvinza (at present one meter gauge) and the construction of a new railway line will be standard gauge 1.435 m and create the most efficient transport route to Musongati between the port of Dar es Salaam and Burundi. The railway project area will be mainly in Tanzania (about 150 km) and only parts will be in Burundi (about 50 km). Should the railway infrastructure be developed in Burundi through the initiatives proposed in the Infrastructure Action Plan (see AfDB (2009)), a siding and supporting infrastructure will be required at Musongati for the unloading of containers and bulk commodities. Facilities will include laydown areas, overhead crane facilities for container handling and, potentially, a load-out station for bulk commodity handling. Final design of this infrastructure will be dependent on the processing option chosen. Rail sliding from Uvinza to Musongati is estimated to be constructed at about US\$ 50m.                                                                                                                                                                                                                                          |
| Port         | Burundi is an inland country surrounded by Tanzania and Rwanda. Government of Burundi has recognised that increased regional economic integration is vital to improve access, attract investment, stimulate economic growth and to reduce transportation costs for freight to and from the ports of Mombasa and Dar es Salaam. Lake Tanganyika is being rehabilitated through joint funding from the African Development Bank (AfDB) and the European Union in order to reinforce local transportation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Energy       | <p>No grid power is available in the Musongati project area. There is currently insufficient power in Burundi as a whole to support the development of the Musongati project. A significant increase in power generation capacity and stable uninterrupted supply are therefore key requirements for the further development of the project. The global weighted-average total installed cost of new hydropower in 2021 was US\$ 2,135/kW for large projects (over 10 MW) and US\$ 2,000/kW for small projects (less than 10 MW). The proposed Musongati operation will use a maximum of 110 MW of electrical power to produce 50,000 t of nickel per annum at full production; approximately 30 MW of this will be co-generated, which means that the project will require an additional 80 MW of power which it is anticipated to be generated from new hydropower sources. Estimated power requirements at each development phase are:</p> <ul style="list-style-type: none"> <li>• 10,000 t of nickel per annum: 17.5 MW</li> <li>• 30,000 t of nickel per annum: 80 MW</li> <li>• 50,000 t of nickel per annum: 110 MW.</li> </ul> <p>The total installed power of selected power generation sites is planned to be 95.8 MW but as they are remote from the Musongati project site transmission losses are likely.</p> |
| GHG emission | General shortage of electricity, which leads to the opportunity of renewable energy generation, e.g. hydropower as planned to avoid/reduce carbon emissions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Water        | The mineralised laterite is extremely wet, with a moisture content of 30–35%, so that water will not be used in the mining operation. Mining will take place below the water table and water will be released during the mining operation. This water will be pumped to storage and settlement facilities where it will be used in the metallurgical processing. Potential make-up water could be drawn from two rivers within 5–6 km from the site. Water handling facilities in the pit and tailings dams will be designed so as to capture rainwater and thus further augment the supply.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

Table 21 Infrastructure assessment of Musongati project, Burundi

### 3.13.5 Further reading

African Development Bank (AfDB) (2009): An Infrastructure Action Plan for Burundi - Accelerating Regional Integration.

<https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/An%20Infrastructure%20Action%20Plan%20for%20Burundi%20-%20Main%20Report%20v1.2.pdf> (assessed 25.09.23)

BMM International Limited (2011a): A Bankable Feasibility Study of the Musongati Nickel Laterite Project, Republic of Burundi. July 2011, 215 pages.

BMM International Limited (2011b): An Environmental and Social Impacts Study of the Musongati Nickel Laterite Project, Republic of Burundi. October 2011, 111 pages.

European Union (EU) (2023): Indicative, non-exhaustive list of conflict-affected and high-risk areas under Regulation (EU) 2017/821. <https://www.cahraslist.net/cahras#BDI> (accessed 15.09.2023)

### 3.14 Samapleu Ni-Cu (-PGE-Co) sulphide project (Côte d'Ivoire)

Information as of 01/2024

#### 3.14.1 General project background

|                                    |                                                                                                                                                                                                                                     |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Nickel, copper                                                                                                                                                                                                                      |
| <b>Other commodities</b>           | PGE, cobalt, gold, chromium                                                                                                                                                                                                         |
| <b>Location</b>                    | Montagnes, Côte d'Ivoire<br>7°46' N, 7°53' W, 400 – 1,200 m.a.s.l.                                                                                                                                                                  |
| <b>License type</b>                | Exploration licenses PR 838 (Samapleu-Est), PR 839 (Samapleu-Ouest), PR 300 (Zérégouiné), PR 604 (Grata) and PR 837 (Zoupleu) (839 km <sup>2</sup> ), partly to be renewed                                                          |
| <b>License owner / operator</b>    | 60 % Sama Nickel Corp., private company (70 % Sama Resources Inc., public company; 30 % Ivanhoe Electric, public company), 40 % Côte d'Ivoire gov.                                                                                  |
| <b>Contact</b>                     | 1320 Graham Boulevard, Suite 132, Ville Mont-Royal<br>Mount Royal, Quebec H3P 3C8, Canada<br><a href="http://www.samaresources.com">www.samaresources.com</a><br><a href="mailto:info@samaresources.com">info@samaresources.com</a> |
| <b>Project status</b>              | Reserves Development - Prefeasibility/Scoping                                                                                                                                                                                       |
| <b>Possible production by 2030</b> | unlikely                                                                                                                                                                                                                            |



Figure 14. Samapleu project location, Côte d'Ivoire

### 3.14.2 Economic assessment

#### General project background:

Nickel mineralisation in the Samapleu area was discovered in the 1970s. The current owner Sama Nickel Corp. (SNC) has been actively exploring since 2009. The project area (Samapleu and Grata, both considered in the resource estimate) is characterised by a series of feeder systems of magmatic material vertically crosscutting Archean country rocks and thus creating a magmatic migmatite complex with locally well-preserved mafic to ultramafic rock units. Sulphide mineralisation in the Samapleu and Grata deposits extends from surface up to a depth of 300 m, laterally up to 850 m and consists predominantly of pyrrhotite, pentlandite and chalcopyrite, with subordinate amounts of pyrite, PGE and chromite. The thickness of the laterite profile is typically between 30 m and 40 m. In 2020, Sama published a preliminary economic assessment (PEA), which considered the production of refined nickel and iron carbonyl powders as well as copper concentrates. The company plans the completion of an updated PEA for Q1/2024 envisaging the production of nickel and copper concentrates for sale to smelters with payable palladium, platinum and cobalt amounts. Sama seeks investment for further exploration and feasibility studies. They also want to start building the mine and the processing plant.

#### Project description:

|                                                |                                                                                                                        |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                               | Ortho-magmatic Ni-Cu(-Co) sulphides                                                                                    |
| NI 43-101 compliant resources                  | 116.9 Mt @ 0.25 % Ni, 0.23 % Cu, 0.01 % Co, 0.1 g/t Pt, 0.3 g/t Pd                                                     |
| Share of global nickel resources               | 0.1 % ( <i>USGS estimate global Ni resources of 300 Mt</i> )                                                           |
| Share of global copper resources               | 0.013 % ( <i>USGS estimate global Cu resources of 2100 Mt</i> )                                                        |
| Share of global cobalt resources               | 0.05 % ( <i>USGS estimate global cobalt resources of 25 Mt</i> )                                                       |
| Share of global PGE resources                  | 0.05 % ( <i>USGS estimate global PGE resources of 0.1 Mt</i> )                                                         |
| Waste to ore ratio                             | 1.2 for 44.42 Mt                                                                                                       |
| Annual production                              | 2.3 Mt of ore, 39 kt Ni concentrate (10.34 % Ni content), 15 kt Cu concentrate (23 % Cu content)                       |
| Life of mine                                   | 20 years (for the 44.42 Mt resource)                                                                                   |
| Investment required                            | US\$ 282m (initial CAPEX for start of mine production)                                                                 |
| Net present value (NPV)                        | US\$ 615m (pre-tax, based on a discount rate of 8 %)                                                                   |
| Share of global nickel production (As of 2020) | 0.12 % (4,032 t of contained nickel in concentrate, rec. 71 %) ( <i>USGS estimate global Ni production of 3.3 Mt</i> ) |
| Share of global copper production (As of 2020) | 0.02 % (3,450 t of contained copper in concentrate, rec. 80 %) ( <i>USGS estimate global Cu production of 22 Mt</i> )  |
| Value addition potential                       | The previous PEA considered the production of nickel and iron carbonyl powders at a carbonyl refining plant.           |

#### Mining and processing:

- The PEA (2020) considers conventional open pit methods employing drilling, blasting, and hauling over three pits. A mineral resource of 44.42 Mt shall be extracted over a 20-year mine life and feed the processing plant at an average grade of 0.24 % nickel and 0.18 % copper.



- Recent processing test work focused on the production of separate copper and nickel concentrates performing sequential copper and nickel rougher flotation, with separate cleaner flotation schemes. In practice, it is perceived that a pyrrhotite flotation step may be added to separate the acid generating sulphides from the majority of the tailings, however this was not tested extensively so far. In contrast to the PEA (2020), the latest processing tests resulted in copper flotation concentrates with grades of 24.8 % copper, 1 % nickel, 1.7 g/t platinum and 6.9 g/t palladium, at a Cu recovery rate of 91 %. Nickel flotation resulted in a concentrate with a nickel grade of 13.9 % as well as 2.2 g/t platinum, 8.1 g/t palladium and 0.59 % cobalt. Recovery rates are 64 % for nickel and 55 % for cobalt. Combined recoveries of platinum and palladium to both concentrates typically ranged from 60-70 %. Gold recoveries were slightly lower.
- As part of the joint venture between Sama Resources and Ivanhoe Electrics, Ivanhoe Electrics has the option to acquire a further 30 % of Sama Nickel by spending US\$ 10m, which includes funding a feasibility study.

### **BGR assessment and comments:**

- The deposit is a medium-grade, medium-tonnage operation with a relatively low waste to ore ratio. Since the PEA (2020), the mineral resource has almost tripled and it is likely that the updated PEA (planned for Q1/2024) will consider adjustments in terms of mine life and annual production. Due to the planned concentrate production, the costs for the carbonyl refining plant will be reduced from the upcoming CAPEX estimate. Resource expansions are possible due to the current advanced exploration on the company's sixth confirmed Ni-Cu-PGE mineralised zone within the 850 km<sup>2</sup> property and more than 20 further target zones.
- Currently, the company plans the sale of copper and nickel concentrates containing payable amounts of platinum, palladium and cobalt to smelters. This renders the previous estimates of operating costs obsolete, however, earlier considerations for the production of nickel carbonyl powder still hold potential for future value addition.

### **3.14.3 ESG assessment**

Due to the early stage of the project, information on many ESG issues and evidence of responsible practice is currently lacking. No major ESG issues were identified so far, which could not be handled by diligent management and operational practice. AMD potential is a risk naturally associated with sulphide deposits and can be controlled, if an adequate handling of mining waste and tailings is ensured. The proximity to several villages and smaller settlements will require a diligent community engagement and adequate operational mitigation measure to prevent negative impacts.



| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                    |
| Environmental management                                           | Environmental management system based on ISO 14000 envisaged; no reports on any incidents found.                                                                                                                                                                                                                                                                                                   |
| Efficient use of energy, renewable energy, GHG emissions reporting | Energy demand is estimated at 21.5 MW; national grid dependable on natural gas (~76 %) and hydropower (~23 %).                                                                                                                                                                                                                                                                                     |
| Water management and consumption                                   | Subtropical area with low water stress; distinct wet and dry seasons. Storm water management plan to be developed as well as mine water balance; low to medium riverine flood risk. No information on water management approach at this project stage; the Méné River is stated as potential water source in the scoping study.                                                                    |
| Pollution prevention                                               | The flotation test work is applying a regular approach for flotation of Cu and Ni; in the scoping study suggests an additional pyrrhotite flotation stage is suggested for separation of acid generating sulphides from the majority of the tailings. Suphidic ores pose general risk of AMD, groundwater in the area is relatively acidic. No specific information on AMD potential is available. |
| Air quality                                                        | Proximity to settlements will require dust mitigation measures (e.g. sprinkling of roadways and TSF).                                                                                                                                                                                                                                                                                              |
| Tailings management                                                | No specific information on tailings management available at this stage of the project; state of the art measures to prevent AMD will be required.                                                                                                                                                                                                                                                  |
| Waste management                                                   | No specific information on waste management available at this stage of the project.                                                                                                                                                                                                                                                                                                                |
| Hazardous materials management                                     | In the flotation test work regularly used reagents for Cu and Ni flotation were applied (e.g. diethylenetriamine, carboxy methyl cellulose, isopropyl xanthate). Anticipating diligent process and water management the risk of the flotation approach is seen as low.                                                                                                                             |
| Noise and vibration                                                | Proximity to settlements will require mitigation measures (e.g. low-impact sequential blasting, construction of noise barrier).                                                                                                                                                                                                                                                                    |
| Protected areas and biodiversity                                   | Project area consists of hilly areas covered with tropical forest and lower grassland areas; the mine site is not close to any protected or key biodiversity area. The area is covered by savannah, forests, fallows and cultivated areas, partly degraded due to agricultural activities.                                                                                                         |
| Mine closure                                                       | No specific information available at this stage of the project A mine closure plan will need to be approved before the start of operations. a provision of US\$ 15m was estimated for the closure and rehabilitation of the mine site.                                                                                                                                                             |
| <b>Social and socio-economic issues</b>                            |                                                                                                                                                                                                                                                                                                                                                                                                    |
| Community health, safety and security                              | Project lies between the town of Yorodougou (~1 km north; ~20.000 inhabitants [2014 census]), and several villages and smaller settlements. The regional capital of Man is located about 50 km to the southeast. Local economy based on subsistence farming, coffee and cocoa plantation, and logging.                                                                                             |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dialogue and engagement with communities and stakeholders | Several community meetings are documented for 2012 and 2017. Company reports to hold community meetings until now, no specific information available.                                                                                                                                                                      |
| Land acquisition and involuntary resettlement             | Some smaller settlements in the area may require resettlement.                                                                                                                                                                                                                                                             |
| Occupational health & safety management                   | Committed to health and safety standards (OHSAS 18000). No detailed information available at this stage of the project.                                                                                                                                                                                                    |
| Workers' rights                                           | Côte d'Ivoire scores 78.5 / 100 in the Labour Rights Index; no indication of any shortcomings on side of Sama found.                                                                                                                                                                                                       |
| Gender and diversity                                      | Sama is committed to non-discriminating employment decisions.                                                                                                                                                                                                                                                              |
| Local value added and community development               | The project provides a development opportunity in a rural area by providing qualified job opportunities. Community development during exploration including: building 150 km access road usable for remote settlements; renovation of water pumps, schools, and healthcare buildings in the surrounding villages.          |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                            |
| Legal compliance                                          | Permits for exploration work granted; no indication of any breaches of law found.                                                                                                                                                                                                                                          |
| Management practices                                      | Sama is committed to implementing comprehensive health & safety policies including environmental, work and community (HSEC) guidance's, commitment to International Council for Mining and Metals (ICMM) principles, basic Code of Business Conduct and Ethics; evidence of practice missing at this stage of the project. |
| Transparency and reporting                                | Listed on the TSX Venture Exchange (TSXV) and also traded at the OTCQX; reports on financial accounts and shareholder structure available.                                                                                                                                                                                 |
| Business ethics                                           | Côte D'Ivoire scores 40/100 in the Corruption Perception Index; Côte D'Ivoire is an EITI country. Whistleblower policy in place, no indication of any unethical practices on side of Sama found.                                                                                                                           |

Table 22. ESG features of Samapleu project, Côte d'Ivoire

### 3.14.4 Infrastructure assessment

#### Potential Investment Needs:

- Road Infrastructure: Construction of access roads to site, paved road to Samapleu exploration camp, and paved road to Lamco Railway.
- Railway Enhancements: Support rehabilitation of Lamco Railway (Liberia) or construct new railway to intercept the Abidjan-Ouagadougou Railway (Cote d'Ivoire).

- Renewable Energy Ventures: Investments needed for the expansion of renewable energies in the region. Solar and biomass should be considered.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | The Samapleu East Exploration Permit 838 ("Permis de recherche minière"; PR838) is located approximately 650 km by road northwest of Abidjan, Ivory Coast. The project is situated close to the village of Yorodougou, about 50 km west of Biankouma and 25 km east of the border with Guinea. The project is host to nickel-copper-PGE sulphide deposits, of which three open pit mines have currently been planned. The rare geological intrusion types found are host to some of the largest Ni-Cu deposits in the world.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Transport                 | Access to the Property from Abidjan is via 225 km of paved road toward the north-west to Yamoussoukro, followed by paved roads to Daloa and Duékoué to the west and north to Man and Biankouma. From Biankouma, the village of Yorodougou, where the Samapleu exploration camp is located, is accessed by a dirt road approximately 35 km toward the west-north-west. The road continues through the town of Sipilou (further 25 km to the west) and to a border post between the Ivory Coast and Guinea. Access from Yorodougou to the Samapleu deposits is via bush tracks servicing small villages and roads constructed by Sama. A new 11 km access road will be constructed to connect the project site with the existing road from Yorodougou to Sipilou. The access road will be constructed to support a typical mining operation with an 8 m wide surface with ditches on each side. Road lighting has not been provided. Culverts will be provided for water crossings and no allowance has been provided for bridges over water crossings. Provision for a network of 3 km of haulage roads has been made. |
| Airport                   | There are 39 airports in Cote d'Ivoire. Cities with modern and largest airports are Abidjan (two airports), Seguela, Ouaga, Lakota and Gagnoa. Three airports are of international standards and six are aerodromes that provide air services. Since 2017, the area is also accessible by plane with a three flight per week between the town of Man and Abidjan. It is a two-hour drive from Man's airport to Sama's base camp in Yorodougou.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Rail access               | The nearest rail infrastructure to the project is the Lamco Railway in Liberia, stretching 266 km from the port of Buchanan to Yekepa at the Guinean border. The track is standard gauge (1,435 mm) and was built in 1963. The Sanniquellie railway station is situated 157 km from Man via the A8 highway and a series of regional roads. ArcelorMittal is undertaking the task of refurbishing the 250 km railway, although this effort is being greatly undermined by illegal scrap dealers. Considerations should be made to constructing a new inland rail segment to intercept the Abidjan-Ouagadougou Railway (around 280 km in a direct line from Man).                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Port                      | There are two deep-sea ports in the Ivory Coast: one in Abidjan and one in San Pedro. The distance to Abidjan is about 650 km while San Pedro is less than 550 km away. The port of San Pedro has a packaged goods terminal with a 4,000 m <sup>2</sup> warehouse opening directly onto the dock. The port can accommodate vessels up to approximately 20,000 dwt with a certified draft depth of 9 m. A future bulk terminal will accommodate vessels up to 35,000 dwt, although this will require a water draft of 14 m.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Energy                    | Sama Resources determined the power demand of the Samapleu operation to be 21.5 MW based on the estimated connected loads, running loads, and running power for the process operation. Power will be supplied to the Project site via a 90-kV overhead transmission line from Man to Danané (around 80 km). The site will be supplied at 11 kV, 3-phase, 50 Hz from the main substation installed adjacent to the concentrator.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GHG emission | To curb CO <sub>2</sub> emissions and reduce power grid dependencies, investments should be directed towards expanding renewable energy sources. Solar and biomass are the most prominent renewable energy sources in Cote d'Ivoire. The geography surrounding the project area should not restrict the selection for renewable energy infrastructure (i.e., large spatial area for solar farm).                                                                              |
| Water        | There is no water utility in the region, but several continuous waterways exist in the project area. The Méné River is considered as the largest potential source of water. Provisions have been made in the project for the following site services: Mine dewatering system; Fresh water intake system for the mill fresh water and fire protection water tank; Reclaim water system from the tailings storage facilities; Domestic water treatment; Sewage waste treatment. |

**Table 23. Infrastructure assessment of Samapleu project, Côte d'Ivoire**

### 3.14.5 Further reading

Sama Resources Inc. (2020): Sama Resources announces positive preliminary economic assessment for Samapleu Project. <https://samaresources.com/news/sama-resources-announces-positive-preliminary-economic-assessment-for-samapleu-project/> (accessed: 29.01.2024)

Sama Nickel Corporation (2023): NI 43-101 Technical Report - Mineral Resource Estimate for the Samapleu and Grata Deposits Project. <https://samaresources.com/wp-content/uploads/2023/08/43-101-Technical-Report.pdf> (accessed: 26.01.2024)

Sama Resources Inc. (2024): Corporate Presentation - Jan 23, 2024. <https://samaresources.com/wp-content/uploads/2024/01/2024-01-23-Sama-Resources-Corporate-Presentation-.pdf> (accessed: 26.01.2024)

### 3.15 Selebi magmatic Ni-Cu (-Co) sulphide project (Botswana)

Information as of 06/2023

#### 3.15.1 General project background

|                                    |                                                                                                                                                                                                                                |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Nickel, copper                                                                                                                                                                                                                 |
| <b>Other commodities</b>           | Cobalt (potentially), silver                                                                                                                                                                                                   |
| <b>Location</b>                    | Central District, Botswana<br>22°03' S, 27°47' E, 780 – 980 m.a.s.l.                                                                                                                                                           |
| <b>License type</b>                | Mining license 2022/1L (115 km <sup>2</sup> , until January 2032)                                                                                                                                                              |
| <b>License owner / operator</b>    | Premium Nickel Resources Ltd. (public company)                                                                                                                                                                                 |
| <b>Contact</b>                     | 100 King Street West, Suite 3400<br>Toronto, Ontario M5X 1A4, Canada<br><a href="http://www.premiumnickelresources.ca">www.premiumnickelresources.ca</a><br><a href="mailto:info@premiumnickel.com">info@premiumnickel.com</a> |
| <b>Project status</b>              | Exploration, digitization and verification of historic data<br>(on care and maintenance since 2016)                                                                                                                            |
| <b>Possible production by 2030</b> | unlikely                                                                                                                                                                                                                       |

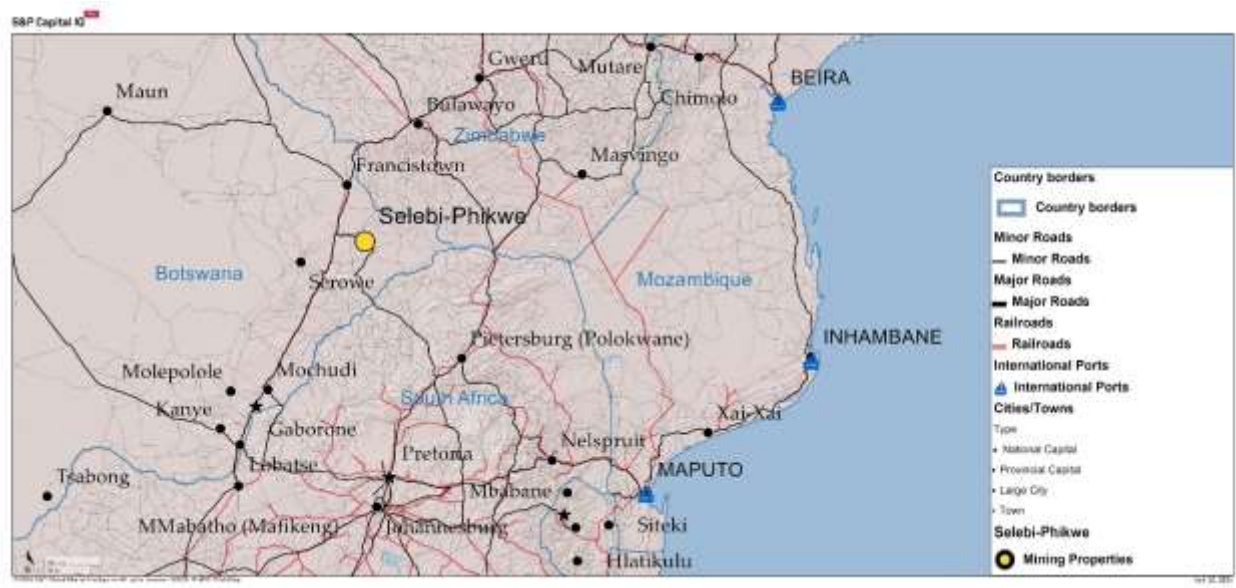


Figure 15. Selebi project location, Botswana

### 3.15.2 Economic assessment

#### General project background:

The Selebi-Phikwe Ni-Cu(-Co) sulphide mineralisation is hosted by metamorphosed mafic to ultramafic sills within the Central Zone of the Limpopo Mobile Belt. The mineralisation is commonly 1 to 3 m thick. Mineralised zones can dip moderately to steeply extending from 150 to over 2,000 m in strike. Exploration in the historical Selebi-Phikwe area was initiated in 1959 followed by open pit and underground operations in the areas named Phikwe, Southeast Extension, Selebi North, and Selebi by Bamangwato Concessions Ltd. (BCL) between 1970 and 2016. In 2022, Premium Nickel Resources Ltd. (PNR) acquired Selebi and Selebi North from BCL with the objective to modernise mining and metallurgy and to produce marketable Cu and Ni-Co concentrates. A NI 43-101 compliant Mineral Resource Estimate is scheduled for 08/2023.

#### Project description:

|                                    |                                                                                                                                                                                          |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Ortho-magmatic Ni-Cu(-Co) sulphides                                                                                                                                                      |
| SAMREC compliant resources         | 33.2 Mt @ 0.78 % Ni, 1.17 % Cu (The resource estimate was provided by BCL in 2016 and is considered historical by PNR)                                                                   |
| Share of global nickel resources   | 0.1 % ( <i>USGS estimate global Ni resources of 300 Mt</i> )                                                                                                                             |
| Share of global copper resources   | 0.02 % ( <i>USGS estimate global Cu resources of 2,100 Mt</i> )                                                                                                                          |
| Waste to ore ratio (whole orebody) | Not determined at this stage                                                                                                                                                             |
| Annual production                  | 1 Mt of ore (2010-2015)<br>6,500 t of contained Ni, 8,400 t of contained Cu                                                                                                              |
| Life of mine                       | Not determined at this stage                                                                                                                                                             |
| Investment required                | US\$ 15.6m (for further exploration and metallurgical tests)                                                                                                                             |
| Net present value (NPV)            | Not determined at this stage                                                                                                                                                             |
| Share of global nickel production  | 0.2 % (6,500 t Ni/a)<br>( <i>USGS estimate global Ni production of 3.3 Mt</i> )                                                                                                          |
| Share of global copper production  | 0.04 % (8,400 t Cu/a)<br>( <i>USGS estimate global Cu production of 22 Mt</i> )                                                                                                          |
| Value addition potential           | Cobalt was not included in the historical resource estimates, but preliminary metallurgical tests indicate cobalt as a potential co-product in the future exportable Ni-Co concentrates. |

#### Mining and processing:

- Underground mining is planned for the Selebi and Selebi North mines. Combined historic production rates from the two mines comprised ~1 Mt of ore/a (containing ~6,500 t of Ni/a and ~8,400 t of Cu/a) for the years 2010-2015. Sulphide mineralisation at Selebi and Selebi North include massive sulphides, semi-massive sulphides, and disseminated sulphides. Mineral processing is planned to include crushing, milling and flotation. Without further smelting/refining, PNR plans to produce readily marketable copper and nickel concentrates.



- The ore body considered for production by PNR is located at greater depth compared to historically exploited ore bodies. PNR plans to address potential higher operating costs with mining and processing techniques that are more efficient, and the additional sale of cobalt.
- PNR seeks US\$ 15.6m investment for their Phase 1: exploration and support of metallurgical studies, to advance existing development at Selebi North, to promote accessibility for deep target drilling, and to maintain the existing infrastructure; and Phase 2: development of an underground exploration drift at Selebi Main, additional drilling and technical studies, permitting, advanced metallurgical, engineering, and environmental studies, including the completion of a Preliminary Economic Assessment.

#### **BGR assessment and comments:**

- After more than 40 years of mining, the former operator BCL categorised their Selebi-Phikwe project as “depleted” based on economic assessment criteria including costs of the processing and smelting plants as well as expected copper and nickel prices of US\$ 6,600/t and US\$ 17,600/t, respectively. PNR considers these price expectations outdated. Indeed, during the last 5 years, both copper and nickel prices were highly variable, but ranging between US\$ 6,000/t and US\$ 10,000/t as well as between US\$ 15,000/t and US\$ 45,000/t, respectively. The price of cobalt, whose content has not yet been estimated for Selebi, has also fluctuated strongly between US\$ 26,000/t and US\$ 82,000/t and is currently being traded at US\$ 33,000/t.
- PNR targets Ni concentrates grading up to 12 % Ni and copper concentrates grading up to 30 % Cu. SLR Consulting Ltd. (prepared the Technical Report NI 43-101) did not consider sample selection and collection involved in the metallurgical testing as best practice, thus the gathered results may not be indicative of the expected metallurgical performance. PNR assessed BCL's existing smelter as obsolete and decided against its acquisition. It is not yet clear whether PNR will move part of the value chain to (non-African) countries or process the Selebi ore in a potential hydrometallurgical plant in the company's Selkirk mine in Botswana.
- The Selebi Project is readily accessed via paved and gravel roads and a railway spur from the town of Selebi-Phikwe (~52,000 inhabitants). Selebi-Phikwe is connected to Serule (~57 km east from the project) by a paved road and a railway line, joining the main line from Gaborone to Francistown. PNR considers partly sourcing the water for the mining operations from dewatering Shaft 2. Power supply is transmitted and managed by Botswana Power Corporation (BPC) and is supplied through the National Grid via a 220/66/11 kV substation.
- North American Nickel Inc. (Vancouver-based junior company) became a founding shareholder in PNR, currently holding 10 % of issued and outstanding shares together with a warrant that entitles them to acquire an additional undiluted 15% interest in PNR, for an exercise price of US\$ 10m.



### 3.15.3 ESG assessment

Due to the early stage of the project, information on many ESG issues and evidence of responsible practice is currently lacking. No major ESG issues were identified at this stage. AMD potential is a risk naturally associated with sulphide deposits and can be controlled, if an adequate handling of mining waste and tailings is ensured. As the project seeks to restart an inactive mine site, overall risks of negative impacts are considerably lower, compared to a greenfield project in an undisturbed environment. Restarting mining actually holds the opportunity of recreating jobs in the community, which were lost with the previous stop of mining. It is not known if liabilities from the former mining area are part of the financial obligations for PNR, but rehabilitation of currently abandoned areas is a relevant issue. Also, it is recommended to assess the base line e.g. of potential site contamination before new operations start, as impacts from former and current mining can hardly be separated in retrospective.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Environmental Management                                           | No reports on incidents found. No evidence on responsible management practice at this early stage of the project. No ESIA information in technical reports.                                                                                                                                                                                                                                                           |
| Efficient use of energy, renewable energy, GHG emissions reporting | No information on energy use available at this stage of the project. Supply from grid anticipated; national grid almost exclusively based on fossil energy.                                                                                                                                                                                                                                                           |
| Water management and consumption                                   | Project site in arid area with low water use, the supply for the town of Selebi-Phikwe is stated as adequate. Previous mining operation sourced water from an underground aquifer by dewatering the shafts; currently ongoing dewatering operations indicate potential for supply from this source.                                                                                                                   |
| Pollution prevention                                               | Risk of acid mine drainage due to sulphide deposits, adequate tailings and mine waste management required. Pollution from historic mining activities might be relevant also for future operations. Sulphur emissions from onsite flash furnace are stated as major source of pollution from historic mining operations, PNR does not plan to reinstate smelting operations; no information on historic AMD pollution. |
| Air quality                                                        | Proximity to the settlement of Selebi-Phikwe requires special care for dust suppression measures at above ground disposal facilities.                                                                                                                                                                                                                                                                                 |
| Tailings management                                                | Planned flotation technology requires a tailings facility; tailings facility from previous mining exists at the site. No information on tailings management available at this stage of the project.                                                                                                                                                                                                                   |
| Waste management                                                   | AMD potential of the ore requires prevention or adequate treatment of water discharge from disposal facilities. No information on waste management available at this stage of the project.                                                                                                                                                                                                                            |
| Hazardous materials management                                     | Flotation and use of required reagents is considered low risk assuming responsible handling; specific information was not available.                                                                                                                                                                                                                                                                                  |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Noise and vibration                                       | Underground mining in proximity to settlements require prevention / minimisation measures for vibration (e.g. low-impact sequential blasting) and ground subsidence (e.g. proper underground support; backfilling); information on planned measures not yet available.                                                                                                 |
| Protected areas and biodiversity                          | The project is not located in or close to a key biodiversity area or other designated protected area. Project site is a historical mining area; expected biodiversity impacts are low.                                                                                                                                                                                 |
| Mine closure                                              | No information on mine closure available at this stage of the project. Liability for the rehabilitation of old mining areas unknown; eventual rehabilitation of the historic tailing facility and slagheap as well as nearby contaminated soil represents an opportunity for a positive impact.                                                                        |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                        |
| Community health, safety and security                     | The project site is directly bordering the town of Selebi-Phikwe (~52,000 inhabitants), which developed as a mining town around previous mining operations (on care and maintenance since 2016). As PNR seeks to restart mining operations at the historic site, potential negative impacts from the operation on local communities are considered generally low risk. |
| Dialogue and engagement with communities and stakeholders | No information on stakeholder engagement available at this stage of the project.                                                                                                                                                                                                                                                                                       |
| Land acquisition and involuntary resettlement             | Re-opening of historic mine site and underground mining; no significant impacts are anticipated.                                                                                                                                                                                                                                                                       |
| Occupational health & safety management                   | No information on OHS management available at this stage of the project.                                                                                                                                                                                                                                                                                               |
| Workers' rights                                           | Botswana scores 42/100 in the Labour Rights Index. No indication of non-compliance with fundamental workers' rights on project site found.                                                                                                                                                                                                                             |
| Gender and diversity                                      | No information / evidence on gender and diversity policies available at this stage of the project.                                                                                                                                                                                                                                                                     |
| Local value added and community                           | No information on CSR measures available at this stage of the project. Restarting of mining operations holds the opportunity of recreating jobs in the community lost with the stop of previous mining operations. Royalty agreement of 2 % net smelter return; 25 % corporate income tax.                                                                             |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                        |
| Legal compliance                                          | PNR has all required permits for the exploration work.                                                                                                                                                                                                                                                                                                                 |
| Management practices                                      | PNR is committed to basic Code of Business Conduct and Ethics, and Sustainable Development Policy; evidence of practice missing at this stage of the project.                                                                                                                                                                                                          |
| Transparency and reporting                                | Listed on the TSX Venture Exchange (TSXV) and also traded at the OTCQX; reports on financial accounts and shareholder structure available.                                                                                                                                                                                                                             |
| Business ethics                                           | Botswana scores 59/100 in the corruption perception index; Botswana is not an EITI country. No indication of unethical practices found.                                                                                                                                                                                                                                |

Table 24. ESG features of Selebi project, Botswana

### 3.15.4 Further reading

IndustriALL (2016): 6,000 jobs to go at state-owned mines in Botswana. <https://www.industrialunion.org/over-6000-jobs-to-go-at-state-owned-mines-in-botswana> (accessed 14.06.2023)

Premium Nickel Resources Ltd. (2022): Code of Business Conduct and Ethics. [https://premiumnickelresources.ca/site/assets/files/6475/pnrl\\_-\\_code\\_of\\_conduct\\_and\\_ethics\\_august\\_2022.pdf](https://premiumnickelresources.ca/site/assets/files/6475/pnrl_-_code_of_conduct_and_ethics_august_2022.pdf) (assessed 12.06.2023)

Premium Nickel Resources Ltd. (2022): Sustainable Development Policy. [https://premiumnickelresources.ca/site/assets/files/6476/pnrl\\_sustainability\\_policy\\_august\\_2022.pdf](https://premiumnickelresources.ca/site/assets/files/6476/pnrl_sustainability_policy_august_2022.pdf) (assessed 12.06.2023)

SLR Consulting (2022): Technical Report on the Selebi Mines, Central District, Republic of Botswana, Report for NI 43-101. [https://premiumnickelresources.ca/site/assets/files/6643/selebi\\_ni\\_43-101\\_report.pdf](https://premiumnickelresources.ca/site/assets/files/6643/selebi_ni_43-101_report.pdf) (accessed 12.06.2023)

### 3.16 Western Foreland sediment-hosted Cu project (DR Congo)

Information as of 12/2023

#### 3.16.1 General project background

|                                    |                                                                                                                                                                                                                                                                                                      |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Copper                                                                                                                                                                                                                                                                                               |
| <b>Location</b>                    | Lualaba, Dem. Rep. Congo<br>10°51' S, 24°58' E, 1100 – 1350 m.a.s.l.                                                                                                                                                                                                                                 |
| <b>License type</b>                | Mining licenses PE704, 706, 708, 714, valid until 16.04.2046, and additional exploration licenses (PR)                                                                                                                                                                                               |
| <b>License owner / operator</b>    | Local JV: 80 % Ivanhoe Mines Ltd. (public company)<br>10 % DRC gov., 10 % Congolese private company                                                                                                                                                                                                  |
| <b>Contact</b>                     | 999 Canada Place, Suite 606, Vancouver,<br>British Columbia V6C 3E1, Canada<br><a href="https://www.ivanhoemines.com/">https://www.ivanhoemines.com/</a><br><a href="mailto:info@ivanhoemines.com">info@ivanhoemines.com</a><br><a href="mailto:TommyH@ivanhoemines.com">TommyH@ivanhoemines.com</a> |
| <b>Project status</b>              | Reserves development                                                                                                                                                                                                                                                                                 |
| <b>Possible production by 2030</b> | Unlikely                                                                                                                                                                                                                                                                                             |

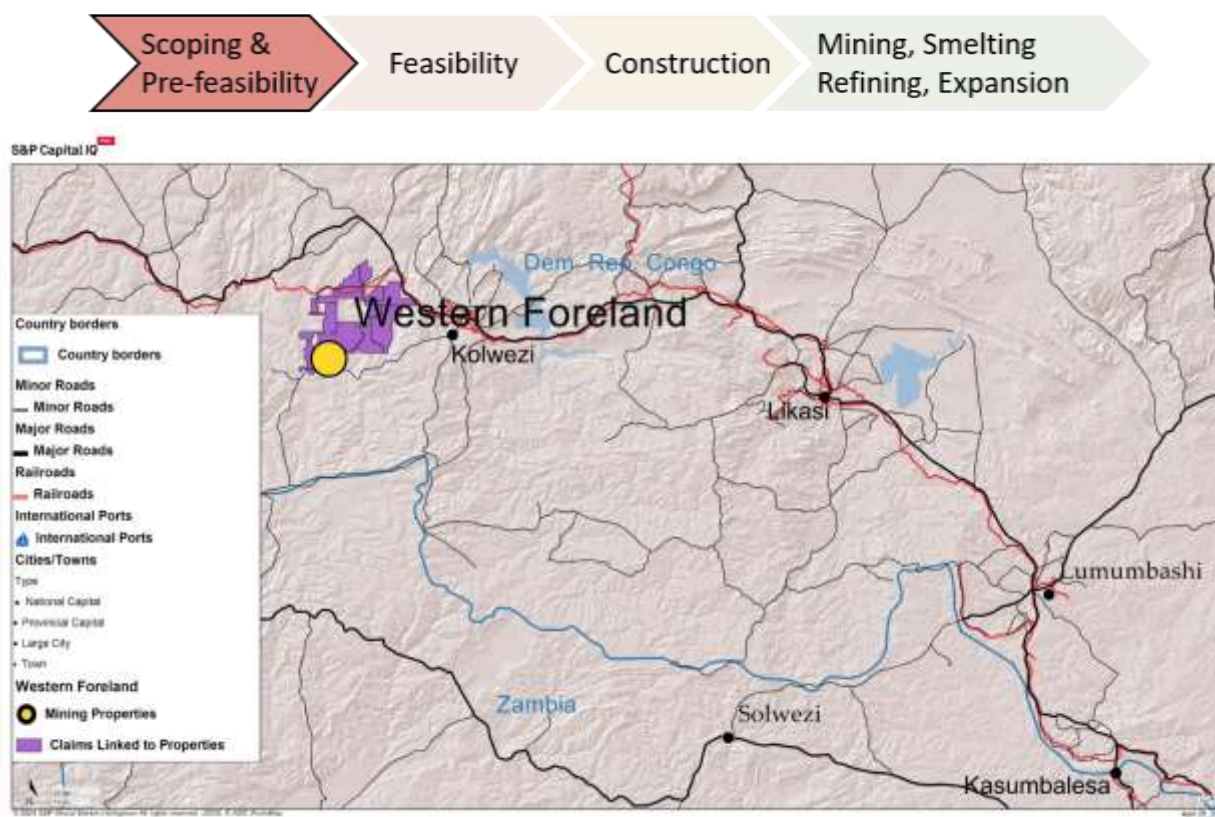


Figure 16. Western Foreland project location, DR Congo

### 3.16.2 Economic assessment

#### General project background:

The Western Foreland exploration project comprises an area of 2,407 km<sup>2</sup>, located mostly west of the Kamoa-Kakula Copper Complex, one of the largest (combined) copper mines in the world. Ivanhoe Mines controls both Western Foreland and Kamoa-Kakula. So far, three copper deposits have been discovered within the Western Foreland exploration area: Makoko, Kiala, and, most recently, Kitoko. Exploration drilling is on-going and maiden resource estimates were recently provided for Makoko and Kiala. Exploration is most advanced at Makoko where drilling has defined a flat-lying, stratiform copper deposit that is geologically similar to Kamoa-Kakula. The primary mineralised zone (700 m wide, 3.8 km long, 5-6 m thick) shows highest grades at 300-600 m depth while a second, shallower zone of mineralisation was found as well.

#### Project description:

|                                              |                                                                                                                                                                                                                                                                                            |
|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                             | Stratiform, sediment-hosted copper deposit                                                                                                                                                                                                                                                 |
| CIM compliant resources (@1 % cut-off grade) | Makoko: 259 Mt @ 1.82 % Cu; Kiala: 28 Mt @ 2.56 % Cu                                                                                                                                                                                                                                       |
| Share of global copper resources             | 0.26 % ( <i>USGS estimate global Cu resources of 2,100 Mt</i> ); expected to grow with on-going exploration                                                                                                                                                                                |
| Waste to ore ratio (whole orebody)           | Expected to be low for underground mining                                                                                                                                                                                                                                                  |
| Annual production                            | Not yet defined for Western Foreland. Neighbouring Kamoa-Kakula, with plans for two separate concentrators, currently expands from 7.6 Mt/a to a combined processing capacity of 14 Mt/a (Phase 3) or even 19 Mt/a (Phase 4) of copper ore, making it one of the largest mines in the DRC. |
| Life of mine                                 | Not yet defined                                                                                                                                                                                                                                                                            |
| Investment required                          | 2024 exploration budget at US\$ 90m. CAPEX for mine development not yet defined (multi-billion US\$ expected).                                                                                                                                                                             |
| Net present value (NPV)                      | Not yet defined                                                                                                                                                                                                                                                                            |
| Share of global copper production            | Not yet defined                                                                                                                                                                                                                                                                            |
| Value addition potential                     | Ivanhoe plans the construction of another concentrator and a copper smelter as well as an acid plant at Kamoa-Kakula. The Kamoa employee training centre might eventually benefit other stakeholders, too.                                                                                 |

#### Mining and processing:

- Given the similarities between the Kamoa-Kakula and Western Foreland mineralisation, Ivanhoe will likely use similar mining methods. At Kamoa-Kakula underground methods comprise primarily drift-and-fill mining as well as hanging wall access drift-and-fill mining of identified mining areas with a dip greater than 25°. Underground mines are accessed via declines (max. gradient of 9°), wide enough to accommodate both a conveyor as well as mobile equipment, such as load haul dumpers or trucks. Shallow mineralisation at Makoko is potentially amenable to heap leaching.

- Currently, mineral processing at the Kakula concentrator includes crushing, milling, flotation and filtering. The high-grade (50%) copper concentrate is partly directly exported, partly processed by a third-party smelter in Kolwezi. Ivanhoe plans the construction of its own on-site copper smelter employing the Direct to Blister Furnace technology; this requires the inclusion of a slag-cleaning furnace, whose slag needs re-processing by flotation to recover residual copper. This existing or planned infrastructure at Kamoa-Kakula might create synergies with eventual Western Foreland mine development.

#### **BGR assessment and comments:**

- Exploration of the Western Foreland concessions is at an early stage. Makoko is the only prospect with significant drilling so far (59 km) and this only covered an area of ~16 km<sup>2</sup>, outlining a mineralised corridor 700 m wide and at least 4 km in length. Considering the huge land package covered by exploration/mining concessions (2,400 km<sup>2</sup>), the immediate vicinity to the world-class Kamoa-Kakula copper deposit, and the open-ended nature of the stratiform mineralisation encountered at Makoko and Kiala, there is significant upside to discover more copper resources. Copper grades encountered so far (~2 %) are lower than at Kakula but nonetheless appear economic at current copper price levels. Ivanhoe successfully brought Kamoa-Kakula in production relatively rapidly and might aim to replicate this at Western Foreland.
- In December 2023, Ivanhoe raised C\$ 500m to expand its exploration activities, with a significant share dedicated to Western Foreland exploration. Mine expansion at Kamoa-Kakula has an expected CAPEX of ~US\$ 10bn, including for the construction of underground facilities, a smelter, power infrastructure, construction, concentrator facilities and a railway line. This cost estimate does not refer to the development of Western Foreland but generally illustrates the scale of potential investment needed. Lobito railway corridor development is positive for project economics. Sufficient power supply will be critical for Ivanhoe's plans at Kamoa-Kakula and Western Foreland. At a technical level, one of Ivanhoe's immediate concerns for expanding Western Foreland exploration is to ensure all-seasons access to the remote area.
- Certain parts of Western Foreland might be affected by legal risks raised in an NGO report in 2022. The report alleges that the initial Western Foreland exploration licenses, granted in 2003-2005, should have expired by 2018-2020 at the latest. At that time, Ivanhoe had just discovered Makoko and, "racing against the clock," intensified exploration through 2021-2022. The NGO inquires whether conversion of the key exploration licenses into mining permits was done correctly while pointing out the potential involvement of a foreign public official (president Kabila's brother) as owner of a JV partner, which might cause corruption concerns.



### 3.16.3 ESG assessment

As a relatively early-stage exploration project with a recently defined maiden resource, detailed studies on ESG impacts and potential mining activities are not yet available. The following ESG evaluation therefore partly draws on comparisons to Ivanhoe's major Kamo-Kakula copper mine, which shows a similar style of mineralisation and is located just next to the Western Foreland concessions. At this stage, ESG concerns associated with Western Foreland mainly relate to governance questions. In contrast to many other copper mines in the DRC, artisanal and small-scale mining is currently not a relevant economic activity in the area, owing to the deep-seated nature of copper mineralisation and the distance to large cities and major roads.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Environmental management                                           | Ivanhoe states that its environmental risk management is aligned to ISO 14001; two-year external environmental audit frequency in the DRC; environmental monitoring against IFC performance standards; environmental management in line with DRC national regulations.                                                                                                                                                             |
| Efficient use of energy, renewable energy, GHG emissions reporting | Due to early project stage, no information on expected GHG emissions for future mine operation available. Two Ivanhoe mines currently in operation in the DRC source 100% of electricity from hydropower, using the company's facilities at Inga II and Mwadingusha. Kamo-Kakula carbon emissions are low (0.15 t CO <sub>2</sub> e /t Cu; scope 1, 2022). Ivanhoe aligns with the TCFD recommendations.                           |
| Water management and consumption                                   | The Kolwezi region is considered a low water stress area (Aqueduct Water Risk Atlas). Due to seasonal high rainfall, potential future underground mining is subject to increased flooding risks. Water consumption at Kamo-Kakula is 11% of total water withdrawal (from groundwater); the remainder is discharged to local watercourses. Ivanhoe uses the WWF Water Risk Filter and WRI Aqueduct Tool to assess site water risks. |
| Pollution prevention                                               | Sulfide mineralisation might potentially cause acid mine drainage. For mining at Kamo-Kakula, Ivanhoe manages risks of polluted water overflow through a stormwater management plan.                                                                                                                                                                                                                                               |
| Air quality                                                        | There are no significant historical mining legacies that would increase dust emissions. The area lies >30 km southwest from the major city of Kolwezi and hosts a few dozen villages. However, current third-party smelting in Kolwezi and future internal on-site smelting implies additional need for monitoring, as does the high level of trucking to and from the site.                                                       |
| Tailings management                                                | Potential future mine tailings at Western Foreland likely similar to the TSF at Kamo-Kakula where Ivanhoe works towards GISTM alignment. The TSF there has lined trenches for stormwater runoff diversion and a curtain-drain system for seepage. This should contain any metals and chemicals within the processing plant, settling ponds and the TSF itself.                                                                     |
| Waste management                                                   | Waste reduction strategy under development at Ivanhoe corporate level. Sorting to facilitate reuse and recycling. Landfill for non-hazardous waste, else secure area storage of industrial or hazardous waste.                                                                                                                                                                                                                     |



| ESG category                                                                                         | Assessment                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hazardous materials management                                                                       | Ivanhoe is familiar with managing flotation and other chemicals at the Kamoa-Kakula concentrator. Potential future heap leaching for shallow mineralisation may necessitate the use of additional chemicals.                                                                                                                                                         |
| Noise and vibration                                                                                  | Low risk during exploration. During the mining stage, at Kamoa-Kakula, there are perceptible ground but no airborne vibrations at some local villages. High background noise levels, but below IFC guidelines.                                                                                                                                                       |
| Protected areas and biodiversity                                                                     | No formal key biodiversity area. Local “dilungu” watershed grasslands with important hydrological functions and hosting critical habitat of orchid species; 92% of their original extent remains intact.                                                                                                                                                             |
| Mine closure                                                                                         | Mine or associated closure plan not yet available for Western Foreland. At Kamoa-Kakula, conceptual closure plan in place, to be updated.                                                                                                                                                                                                                            |
| <b>Social and socio-economic issues</b>                                                              |                                                                                                                                                                                                                                                                                                                                                                      |
| Community health, safety and security                                                                | Somewhat lower risks than for mines closer to Kolwezi; Western Foreland is located at a larger distance to major towns and there is no artisanal and small-scale mining with associated safety and other concerns. Ivanhoe constructed community health centres and clinic at Kamoa-Kakula.                                                                          |
| Dialogue and engagement with communities and stakeholders                                            | Robust community engagement process initially in place at Kamoa-Kakula, but some grievances (related to resettlement) and allegedly reduced engagement efforts later on. Cultural heritage evaluations related to relocation of graves and respect of sacred sites on the Kamoa concessions.                                                                         |
| Land acquisition and involuntary resettlement                                                        | Medium risk due to large land area currently covered by concessions and NGO criticism (Amnesty International 2023) at Kamoa-Kakula. There, community grievances indicate dissatisfaction with substitute housing and infrastructure, based on Ivanhoe’s “like for like” standard for in-kind compensation. No human rights violations alleged, though.               |
| Occupational health & safety management                                                              | Company reports management aligned to ISO 45001. Ivanhoe employs extensive training for its employees at Kamoa-Kakula and has a good safety record, though reported one fatality in 2022. State-of-the-art hospital for employees. No artisanal and small-scale mining on site.                                                                                      |
| Workers' rights                                                                                      | The DRC scores 64.5/100 in the Labour Rights Index. 92% of Ivanhoe’s Kamoa workforce (currently standing at about 12,000) is unionized, 97% are locals. Ivanhoe Mines endorses the ILO core conventions.                                                                                                                                                             |
| Gender and diversity                                                                                 | Ivanhoe Mines self-declares to be an equal opportunity employer and encourages diversity of gender, but notes women are underrepresented in its staff (only 6% of employees at Kamoa-Kakula are female).                                                                                                                                                             |
| Local value added and community development                                                          | The share of local procurement spending for Western Foreland exploration was 68% in 2022 (77% in 2021). At Kamoa-Kakula, Ivanhoe steadily increases local procurement (currently at 70%) and runs an Enterprise and Supplier Development program. From a total Kamoa-Kakula value creation of \$1.9bn, \$1.5bn was reported as created in local communities in 2022. |
| <b>Governance</b>                                                                                    |                                                                                                                                                                                                                                                                                                                                                                      |
| Legal compliance  | Through local subsidiaries and joint ventures, Ivanhoe Mines holds four mining permits and additional exploration permits in the Western Foreland area. The company faces NGO allegations (The Sentry 2022) questioning                                                                                                                                              |

| ESG category               | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | the permit renewal/conversion process and the involvement of foreign public officials, which might have required Ivanhoe to implement anti-corruption measures.                                                                                                                                                                                                                                                                                    |
| Management practices       | Ivanhoe Mines emphasizes alignment with the SDGs while also considering the ICMM principles. The company is operationalizing a sustainability management system framework and sets annual sustainability targets. Ivanhoe considers the IFC performance standards, WB EHS guidelines, and Equator Principles.                                                                                                                                      |
| Transparency and reporting | Ivanhoe Mines regularly files corporate reports in line with Canadian regulatory requirements. The company publishes sustainability reports in line with GRI standards and supports EITI, TCFD and LPRM reporting.                                                                                                                                                                                                                                 |
| Business ethics            | The DRC is an EITI member country and a high-risk location in terms of corruption, scoring 20/100 points in the corruption perceptions index (ranked 162 out of 180 countries). Lualaba province is currently listed as a high-risk area by the European Union due to reported human rights violations. Ivanhoe states it respects the UN Guiding Principles for Business and Human Rights and has a code of business conduct and ethics in place. |

Table 25. ESG features of Western Foreland project, DR Congo

### 3.16.4 Further reading

Amnesty International (2023): Powering change or business as usual? Forced evictions at industrial cobalt and copper mines in the Democratic Republic of the Congo.

<https://www.amnesty.org/en/documents/AFR62/7010/2023/en/> (accessed: 26.01.2024)

Ivanhoe Mines Ltd. (2023a): Ivanhoe Mines Announces the KITOKO Sedimentary Copper Discovery in Western Foreland, Democratic Republic of Congo.

<https://www.ivanhoemines.com/wp-content/uploads/20231128-Kitoko-Copper-Discovery-in-Western-Foreland-vff.pdf> (accessed: 01.12.2023)

Ivanhoe Mines Ltd. (2023b): Ivanhoe Mines Reports Mineral Resources for Makoko and Kiala Discoveries in the Western Foreland. [https://www.ivanhoemines.com/wp-content/uploads/20231113\\_Makoko\\_Kiala\\_Resource-release\\_vF2.pdf](https://www.ivanhoemines.com/wp-content/uploads/20231113_Makoko_Kiala_Resource-release_vF2.pdf) (accessed: 01.12.2023)

Ivanhoe Mines Ltd. (2023c): Sustainability Report 2022. [https://www.ivanhoemines.com/wp-content/uploads/2022\\_sustainability\\_report.pdf](https://www.ivanhoemines.com/wp-content/uploads/2022_sustainability_report.pdf) (accessed 26.01.2024)

OreWin Pty. Ltd. (2023): Kamo-Kalula Integrated Development Plan 2023.

[https://www.ivanhoemines.com/wp-content/uploads/22005kkidp23\\_230316rev1.pdf](https://www.ivanhoemines.com/wp-content/uploads/22005kkidp23_230316rev1.pdf) (accessed 01.12.2023)

The Sentry (2022): Gaming the System: How a Canadian Mining Giant Undermined the Law in the DRC. <https://thesentry.org/reports/gaming-the-system/> (accessed 26.01.2024)

### 3.17 Yacob Dewar Au-Cu (-Ag) weathered VMS project (Eritrea)

Information as of 07/2023

#### 3.17.1 General project background

|                                    |                                                                                                                                                                                                                                                            |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Gold, copper                                                                                                                                                                                                                                               |
| <b>Other commodities</b>           | Silver                                                                                                                                                                                                                                                     |
| <b>Location</b>                    | Gash-Barka, Eritrea<br>15°9' N, 37°10' E, 700 – 1200 m.a.s.l.                                                                                                                                                                                              |
| <b>License type</b>                | Haykota exploration licence (210 km <sup>2</sup> )                                                                                                                                                                                                         |
| <b>License owner / operator</b>    | Andiamo Exploration Ltd.                                                                                                                                                                                                                                   |
| <b>Contact</b>                     | The Portway Centre, 1 Old Sarum Park, Old Sarum,<br>Salisbury SP4 6EB, United Kingdom<br><a href="https://andiamoexploration.co.uk/">https://andiamoexploration.co.uk/</a><br><a href="mailto:info@andiamoexploration.com">info@andiamoexploration.com</a> |
| <b>Project status</b>              | Reserves development - advanced exploration                                                                                                                                                                                                                |
| <b>Possible production by 2030</b> | unlikely                                                                                                                                                                                                                                                   |



Figure 17. Haykota exploration licence area, Eritrea

### 3.17.2 Economic assessment

#### General project background:

The Haykota area has been historically operated at small-scale during the Italian colonial era (prior to 1941) and the British Military Administration (between 1941 and 1951). The Haykota exploration licence hosts volcanogenic massive sulphide (VMS)-style copper-gold mineralisation. Andiamo, the licence holder, traced the related exhalative system over a 60 km strike length. Numerous targets have been identified and are at different exploration stages. The Yacob Dewar project is the most developed and yields a JORC-compliant Mineral Resource Estimate. The mineralisation found at Yacob Dewar is similar to the shallow Au-Cu oxide ore (gossan) found at the large, high-grade Bisha deposit (~140 km to the north). The oxide zone is underlain by a massive sulphide-bearing stratigraphic package with a thickness of ~250 m. The whole sequence strikes north and dips between 35° and 55° to the west. The limits of mineralisation as currently defined, have a strike length of 1.1 km. The oxide mineralisation has a width of as much as 50 m of varying grade and extends down to, and below, the base of weathering at about 50 m below surface. Andiamo seeks investment to complete 25,000 m of exploration drilling during the next two years.

#### Project description:

|                                                          |                                                                                                                                                                                                                                       |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                                         | Gossan mineralisation (surficial oxides) of a VMS Cu-Au deposit                                                                                                                                                                       |
| NI 43-101 compliant resources                            | Au orebody: 1.8 Mt @ 3.15 g/t Au, 0.91 % Cu, 36.25 g/t Ag<br>Cu orebody: 1.3 Mt @ 0.17 g/t Au, 2.85 % Cu, 8.34 g/t Ag                                                                                                                 |
| Share of global copper resources                         | 0.001 % (considering contained Cu in both orebodies)<br>(USGS estimate global Cu resources of 2,100 Mt)                                                                                                                               |
| Waste to ore ratio (whole orebody)                       | Rather low due to selective and surface-near mining                                                                                                                                                                                   |
| Annual production<br>(considering 15 years life of mine) | Au orebody: 20 kt ore, 1.8 koz and 127 t of contained Au and Cu<br>Cu orebody: 20 kt ore, 400 t of contained Cu<br>(based on two scenarios presented by the company considering 90 % and 70 % recoveries for Au and Cu, respectively) |
| Share of global copper production                        | 0.01 % (considering 2,100 t Cu/a, recovery 70 %)<br>(USGS estimate global Cu production of 22 Mt)                                                                                                                                     |
| Life of mine                                             | 10-15 years                                                                                                                                                                                                                           |
| Investment required                                      | US\$ 6.5m for exploration (25,000 m of drilling during the next 2 years); CAPEX for mine construction not available                                                                                                                   |
| Net present value (NPV)                                  | not defined                                                                                                                                                                                                                           |

#### Mining and processing:

- There is no information from Andiamo on the planned mining method. Due to the similarity to Bisha, however, it can be assumed that the oxide zone can be treated by conventional open pit truck-and-shovel mining. Selective mining and the near-surface location suggest low waste-to-ore ratios. The resource is based on two domains, a gold domain with high gold and silver but low copper grades, and a copper domain with high copper but low gold and

silver grades. Oxide ore generally consists of porous iron oxide breccias consisting mostly of hematite and goethite.

- Recovery rates are 90 % for gold, 90 % for silver and 70 % for copper. Recovery methods would employ the carbon-in-leach process for gold and silver recovery and sulphuric acid leaching for copper recovery. These processing steps can be combined in the same processing plant.
- The company considers two major scenarios for the estimation of the operating expenditures (OPEX), which cover the processing of 20 kt ore/a each: (1) the recovery of gold, silver and copper from the gold domain refers to an OPEX of US\$ 36.7/t ore and faces a combined metal value of US\$ 231/t ore; (2) the recovery of copper from the copper domain refers to an OPEX of US\$ 47.7/t ore and faces a copper value of US\$ 231/t ore. It should be noted that the costs quoted here seem rather low and should be reviewed.

#### **BGR assessment and comments:**

- The life of mine has been considered 10 to 15 years; there is potential for further resource growth, with drilling continuing across Andiamo's target pipeline including Hoba, Ber Gebey, Adi Merirey, Shekeret, Shambotai and Frataka as well as 40 underdeveloped targets. Since 2013, the licence area has been reduced in size, concentrating on targets in the eastern half and expanding significantly to the south.
- Andiamo assumes long-term prices of US\$ 8,800/t copper, US\$ 1,650/oz gold and US\$ 24/oz silver, respectively. Copper and silver prices have averaged US\$ 7,431/t copper and US\$ 20.5/oz silver over the last 5 years. Although both metals show positive price trends in recent years, Andiamo's estimates still appear slightly optimistic. Andiamo's gold price estimate of US\$ 1606/oz seems conservative, considering gold price trends over the last five years.
- The licence area is located ~12 km west of the town of Haykota (36,500 inhabitants) and ~170 km west of Eritrea's capital Asmara. Two smaller villages occur within the Haykota licence area. The main, single-carriage, east-west running tarred road between Tesseney and Barentu intersects approximately midway through the Haykota licence area. An all-weather gravel road crosses the southern part of the property. Railway infrastructure in Eritrea is available but is archaic and limited. Unskilled labour can be sourced from local communities, while more skilled labour and specialised services can be sourced from larger urban areas. The port of Massawa is located some 380 km by paved road eastwards on the Red Sea coast.

### 3.17.3 ESG assessment

Due to the early stage of the project detailed information on several ESG issues and specific policy statements are currently missing. It is critical to avoid any spills of hazardous chemicals used in the intended heap leaching process. Human rights violations have occurred under the state conscription system in Eritrea, and conscripts have been involved in mine construction in the past; special caution is needed here. High water stress and agricultural activities in the region bear conflict potential due to competing water and land use demands.

| ESG category                                                                                                         | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Environmental Management                                                                                             | No reports on incidents found; Andiamo claims to be committed to follow the PDAC Excellence in Environmental Exploration (E3) guidelines.                                                                                                                                                                                                                                                                                          |
| Efficient use of energy, renewable energy, GHG emissions reporting                                                   | No specific information on energy use available at this stage; heap leaching as intended processing technology is in general less energy intensive compared to other technologies.                                                                                                                                                                                                                                                 |
| Water management and consumption                                                                                     | No specific information on water use available at this stage. Semi-arid climate with extremely high water stress at the project site; the Gash-Barka region is an important agricultural region in Eritrea, competing water use is possible. Heap leaching technology allows a high recycling rate of the necessary process water, if evaporation losses are kept low. Extremely high riverine flood risk.                         |
| Pollution prevention                                                                                                 | Heap leaching implies the use of hazardous substances (e.g. cyanide, sulphuric acid) to release the metals from the ore minerals; adequate measures to prevent spilling are mandatory (see “Hazardous material management”). AMD potential from mine waste is seen as low risk due to arid climate, selective mining of the weathered oxide ores, and assuming no underground mining and therefore potential mine water discharge. |
| Air quality                                                                                                          | Depending on the mining method, which is not defined at this stage; considered generally low risks due to remote site location.                                                                                                                                                                                                                                                                                                    |
| Tailings management                                                                                                  | Heap leaching does usually not imply fine milling of the ore, therefore a dedicated tailings facility should not be necessary.                                                                                                                                                                                                                                                                                                     |
| Waste management                                                                                                     | Mine waste disposal requires neutralization of the leached ore and adequate remediation of the waste dumps to guarantee no pollutants are released to the environment.                                                                                                                                                                                                                                                             |
| Hazardous materials management    | To prevent the release of leaching solution or leachate to the environment the leach pads have to be sealed off by a liner system, capable of handling occasional rainfall events during wet season. Heap leaching allows efficient recycling of process water; released water has to be treated adequately.                                                                                                                       |
| Noise and vibration                                                                                                  | Depends on the mining method, which is not defined at this stage; considered generally low risks due to remote site location.                                                                                                                                                                                                                                                                                                      |
| Protected areas and biodiversity  | The Gash Setit Wildlife Reserve is a key biodiversity area (IUCN category IV) and is located downstream of the seasonal river Gash which runs in close proximity south of the project area; the riverine area includes of seasonal swamps and artificial marshland for irrigation of farmland, providing nearly                                                                                                                    |



| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | permanent wetlands which is unique in Eritrea. The prevention of contamination is imperative (see “Hazardous materials management”).                                                                                                                                                                                                                                                                  |
| Mine closure                                              | No specific information on mine closure plans at this stage. Andiamo states remediation of all exploration workings has been completed.                                                                                                                                                                                                                                                               |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                       |
| Community health, safety and security                     | Project site in the vicinity of the town Haykota (36,500 inhabitants), next to the road connecting the regional major settlements of Barentu and Tesseney; distance to settlements appears large enough that potentially negative impacts on the local population are considered low risk.                                                                                                            |
| Dialogue and engagement with communities and stakeholders | No specific information on stakeholder dialogue available at this stage.                                                                                                                                                                                                                                                                                                                              |
| Land acquisition and involuntary resettlement             | Project area sparsely populated, need for major resettlement unlikely; competing land use with farmers on the later mining concession is possible; no specific information available at this stage. Area of actual mining operations not specified at this stage; land use requirements partially dependent on geometry of the leach pads and the duration of the leaching process (up to two years). |
| Occupational health & safety management                   | Andiamo stated their OHS policies are in accordance with the UK Health and Safety at Work legislation.                                                                                                                                                                                                                                                                                                |
| Workers' rights                                           | Eritrea is not covered by the Labour Rights Index. The Eritrean government is accused of forcing mining companies to engage governmental construction companies, which use conscript labour thus violating human rights (see Human Rights Watch (2021)); no evidence of misconduct by Andiamo found in this matter.                                                                                   |
| Gender and diversity                                      | No dedicated non-discrimination policy available at this stage.                                                                                                                                                                                                                                                                                                                                       |
| Local value added and community development               | Andiamo is committed to increase the local value of its project where it is practical; aiming to recruit preferably local or national workforce.                                                                                                                                                                                                                                                      |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                       |
| Legal compliance                                          | Haykota exploration licence was granted on 8 July 2009, no indication of any breaches of law found.                                                                                                                                                                                                                                                                                                   |
| Management practices                                      | Basic ESG policies are in place; based on the UK Corporate Governance Code and the QCA Corporate Governance Guidelines for Smaller Quoted Companies. Establishment of a dedicated risk management committee will be considered with growth of Andiamos operations.                                                                                                                                    |
| Transparency and reporting                                | Private limited company; reports on financial accounts and shareholder structure available.                                                                                                                                                                                                                                                                                                           |
| Business ethics                                           | The Gash-Barka region is on the EU list of Conflict-Affected and High-Risk Areas (CAHRA); Eritrea scores 21/100 in the corruption perception index; Eritrea is not an EITI country. No indication of unethical practices by Andiamo found; contractors are required to adhere to corporate policies.                                                                                                  |

Table 26. ESG features of Yacob Dewar project, Eritrea



### 3.17.4 Further reading

Andiamo Exploration Ltd. (2015): Mineral Resource – Yacob Dewar.

[https://andiamoexploration.co.uk/wp-content/uploads/YacobDewar\\_MineralResourceReport.pdf](https://andiamoexploration.co.uk/wp-content/uploads/YacobDewar_MineralResourceReport.pdf)  
(accessed 06.07.23)

Andiamo Exploration Ltd. (2016): Policy Statements and Guidelines for Implementation.

<https://andiamoexploration.co.uk/wp-content/uploads/AndiamoPolicies-2016.pdf> (accessed 15.07.23)

Andiamo Exploration Ltd. (2022): Report of the Directors and Financial Statements for the Year ended 31 December 2021.

[https://andiamoexploration.co.uk/wp-content/uploads/Andiamo\\_AFS\\_Approved\\_2021.pdf](https://andiamoexploration.co.uk/wp-content/uploads/Andiamo_AFS_Approved_2021.pdf) (accessed 15.07.23)

Human Rights Watch (2021): Eritrea – Events of 2020. <https://www.hrw.org/world-report/2021/country-chapters/eritrea> (accessed 18.07.2023)

Minxcon (2021): Andiamo Mauritius Limited NI 43-101 Technical Report on the Andiamo Gold Project, Eritrea. Mineral Resource Report.

[https://andiamoexploration.co.uk/wp-content/uploads/M20-051a\\_Andiamo\\_Resource\\_NI43-101\\_Final\\_Signed.pdf](https://andiamoexploration.co.uk/wp-content/uploads/M20-051a_Andiamo_Resource_NI43-101_Final_Signed.pdf) (accessed 06.07.23)

### 3.18 Zandkopsdrift REE (-Mn) carbonatite project (South Africa)

Information as of 12/2023

#### 3.18.1 General project background

|                                    |                                                                                                                                                                                                                                           |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Neodymium, praseodymium, terbium, dysprosium                                                                                                                                                                                              |
| <b>Other commodities</b>           | Other rare earth elements, manganese sulphate                                                                                                                                                                                             |
| <b>Location</b>                    | Northern Cape Province, South Africa<br>30°52' S, 17°58' E, 150 – 400 m.a.s.l.                                                                                                                                                            |
| <b>License type</b>                | Mining Right granted for 51.45 km <sup>2</sup>                                                                                                                                                                                            |
| <b>License owner / operator</b>    | 65.1 % Frontier Rare Earths Ltd. (Op., previously public company, currently private and controlled by EU shareholders), 26 % historically disadvantaged South African entities/individuals, 8.9 % governmental (KOMIR/KORES, South Korea) |
| <b>Contact</b>                     | 4 Rue Jean-Pierre Probst, L-2352, Luxembourg                                                                                                                                                                                              |
| Direct contact established: Yes    | <a href="https://frontierrareearths.com">https://frontierrareearths.com</a><br><a href="mailto:enquiries@frontierrareearths.com">enquiries@frontierrareearths.com</a>                                                                     |
| <b>Project status</b>              | Prefeasibility study completed (05/2015; updated 2022). Mining right and environmental authorization granted.                                                                                                                             |
| <b>Possible production by 2030</b> | unlikely                                                                                                                                                                                                                                  |



Figure 18. Zandkopsdrift project location, South Africa

### 3.18.2 Economic assessment

#### General project background:

The Zandkopsdrift Mine is hosted by the Zandkopsdrift carbonatite complex, which was explored for manganese (more than 60 years ago), phosphate, niobium and finally for its REE potential. The Zandkopsdrift carbonatite complex is a multi-phase, multi-facies pipe-like intrusion comprising carbonatitic phlogopite breccias and later (intruding) vertical to subvertical, REE-enriched calcio-carbonatite dykes and veins, which occur predominantly in the west to southwest quadrant of the complex. The carbonatitic breccia pipe is circular in shape and ~1 km in diameter. Within the highly weathered upper 80 to 100 m of the complex, supergene REE enrichment (97 % hosted in monazite) and iron-manganese laterite formation took place, which has been targeted by Frontier Rare Earths Limited. A DFS is scheduled to commence in 2024 and on its completion to be followed by a 2-year construction period, with production to commence in 2028. The owner is currently seeking investment for the completion of the DFS, and then for the phase 1 mine and chemical conversion plant constructions. The mine plans to produce mixed rare earths carbonate and battery grade high purity manganese sulphate monohydrate (HPMSM), with the magnet rare earths (Nd, Pr, Tb and Dy) accounting for 93 % of REE revenues at December 2023 prices.

#### Project description:

|                                 |                                                                                                                                                                         |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                | Carbonatite (weathered)                                                                                                                                                 |
| NI 43-101 compliant reserves    | 41.12 Mt @ 1.92 % TREO (889 ppm Pr, 3,051 ppm Nd, 35 ppm Tb, 152 ppm Dy), 4.81 % Mn                                                                                     |
| Share of global TREO reserves   | 0.7 % ( <i>USGS estimate global total REO (TREO) reserves of 120 Mt</i> )                                                                                               |
| Share of global Mn reserves     | 0.1 % ( <i>USGS estimate global Mn reserves of 1700 Mt</i> )                                                                                                            |
| Waste to ore ratio              | 0.6 (Considering the Central and Outer Zone)                                                                                                                            |
| Annual production               | 1 Mt of ore, 17,400 t TREO, 100,000 t battery grade HPMSM (TREO and Mn feed grades of 1.9 and 4.7 %, respectively; TREO and Mn recoveries of 71 and 68 %, respectively) |
| Life of mine                    | 45.5 years                                                                                                                                                              |
| Investment required             | US\$ 491m (Phase 1 CAPEX for mine and processing plant)                                                                                                                 |
| Net present value               | US\$ 3.7bn (based on a REO basket price assumption of US\$ 56,500/t and a HPMSM price of US\$ 2,500/t (10 % discount rate, after tax)                                   |
| Share of global TREO production | 5.7 % ( <i>USGS estimate global TREO production of 280,000 t</i> )                                                                                                      |
| Share of global Mn production   | 0.2 % ( <i>USGS estimate global Mn production of 20 Mt</i> )                                                                                                            |
| Value addition potential        | Possible utilisation of the sulphuric acid obtained as a by-product from Vedanta's proposed zinc smelter in Gamsberg.                                                   |

#### Mining and processing:

- Open pit mining will include a combination of excavation of weathered material (free-dig, ripping) and drill and blast for more competent material. The supergene ore is hosted by the

Central and Outer Zones. The higher-grade Central Zone is targeted for the initial operations followed by a transition into the lower grade Outer Zone material after ~20 years.

- Mineral processing at Zandkopsdrift will include crushing, milling, leaching, and precipitation into a mixed rare earth carbonate as well as manganese recovery (as battery grade HPMSM). The processing plant will produce ~8,700 t of TREO/a and ca. 50,000 t/a of HPMSM for the first four years at full production and then capacity will be doubled until year 15. At this point, REE production will decline due to the lower grade in the Outer Zone to about 13 kt/a from year 18. Frontier expects TREO and Mn recoveries of 71 % and 68 %, respectively. The HPMSM co-product will generate HPMSM revenue of US\$ 13,925/t of REO output. Combined average REO and HPMSM revenue over the life of mine is projected to be US\$ 70,425/t of REO output and with operating costs of US\$ 17,740 generates a gross margin of 75 %.

#### **BGR assessment and comments:**

- The deposit is a medium-grade, medium-tonnage TREO project with a low waste to ore ratio due to the near-surface location of the mineralisation. The long life of mine (45.5 years) can be positive for the development of the region, which will include the employment of local workers directly at the mine site and for infrastructural improvements. Resource upgrade potential lies in the primary, unweathered carbonatitic phlogopite breccias, which yield REE grades below the 1.0 % TREO cut-off. The unweathered REE-enriched calcio-carbonatite dykes and veins have even higher grades and were not integrated into the resource estimates.
- Project revenues and NPV are based on Adamas Intelligence price forecasts for the individual critical magnet REEs, and the magnet REEs (Nd, Pr, Tb and Dy), which account for 93 % of total REE revenues at current prices. The average NdPrO price for the last 5 years is ~US\$ 125,000/t, albeit with strong fluctuations. By comparison, the average NdPrO price used in the Zandkopsdrift project financial model is based on Adamas Intelligence's 2023 price forecasts of US\$ 134,000/t up to 2030 and US\$ 187,000 to 2040. According to Frontier, the EU is the principal target market for the REE and HPMSM production from Zandkopsdrift, and Frontier has commenced offtake discussions with German and French car manufacturers and German wind turbine manufacturers. Due to the stake held by KOMIR/KORES, around 9 % of future annual TREO production could be sent to South Korea.
- Zandkopsdrift is located ~450 km from Cape Town on the N7 highway and ~300 km from the port of Saldanha Bay. A 20 km gravel road, which will be upgraded to a paved road when mine development commences, connects the mine with the N7 and from there the Bitterfontein railhead is within 35 km. A minimum of 40 % of electrical power is planned to be sourced from integrated solar, wind and battery energy storage solutions. The company will operate a desalination plant at the coast 60 km to the southwest, which will supply the project with water.

### 3.18.3 ESG assessment

As the project is still at the feasibility and planning stage, detailed information on various ESG issues are currently not available. Most information below is based on the final Environmental Impact Assessment report published in October 2014. Overall, no major ESG risks have been identified that could not be addressed through responsible management practices. The Th/U content is relatively low compared to other REE projects and radiological assessment concluded that the environmental impact of the radionuclides will be negligible.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Environmental management                                           | An Environmental Management Programme was established as part of the EIA. The final EIA was submitted in Nov 2014 with the overall conclusion that identified negative environmental and socioeconomic impacts can be effectively managed and that the positive impacts outweigh the deleterious effects to a large extent. ISO 14001 certification is envisaged and an Environmental Authorisation for the mine was granted.                                                                                                                                                                          |
| Efficient use of energy, renewable energy, GHG emissions reporting | The South African electricity grid is dominated by coal, which covers around 70 % of installed electricity generation capacity. According to the company, a minimum of 40 % of electrical power will be sourced from integrated solar, wind and battery energy storage system at the commencement of operations, with the objective to expand to 100 % as the project progresses, which Frontier claims will make it one of the lowest carbon emission REE and HPMSM producers in the world.                                                                                                           |
| Water management and consumption                                   | The project site is located in an arid area with low water use. Although no specific information on water consumption is available at this stage, the EIA identified a decrease in groundwater levels and a loss of groundwater supply due to pit dewatering as significant impacts (on the project site, not at a regional scale). However, the water management of the mine and processing plant has been adequately addressed in the generation of process water supply from a desalination plant that will be developed to supply the mine. Storm water management plans are addressed in the EIA. |
| Pollution prevention                                               | The risk of acid mine drainage is minimal due to the addition of lime in the process and the neutralising effect of carbonatite in the host rocks, respectively. Contamination of groundwater by sulphates or heavy minerals is unlikely. Despite the natural Th/U content, there is a very low radioactive signature (60-70 ppm U and 215-235 ppm Th) compared to other REE deposits. A Radiological Public Safety and Impact Assessment carried out as part of the EIA process concluded that “the environmental impact of the radionuclides will be negligible”.                                    |
| Air quality                                                        | The National Ambient Air Quality Standards can be met through appropriate environmental management (mitigation measures and ambient monitoring). Therefore, and in view of the remoteness of the site, the overall impact on air quality is considered to be low.                                                                                                                                                                                                                                                                                                                                      |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Tailings management                                       | The radionuclides will be disposed to a double-lined impurity TSF. Due to the low radioactive signature, waste disposal is permitted on site. The site is in an area of medium to high riverine flood risk (according to Aqueduct Water Risk Atlas).                                                                                                                                                                                                                                                                                                                      |
| Waste management                                          | A waste management policy or corresponding goals that go beyond the tailings management have not yet been formulated.                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Hazardous materials management                            | Radiological aspects will be regulated by the National Nuclear Regulator. The radionuclides will be removed by precipitation. The total effective doses calculated in the specialist assessment indicate that for an exposure to airborne radionuclides, the dose to members of the public will not exceed regulatory limits.                                                                                                                                                                                                                                             |
| Noise and vibration                                       | Due to the remote location of the site, it is not expected that the mine will be audible at the nearest receptors. According to EIA, impacts are negligible.                                                                                                                                                                                                                                                                                                                                                                                                              |
| Protected areas and biodiversity                          | The property lies within the Karoo - Namib Floristic Region within the Succulent Karoo biome, which is known to support the richest flora of any arid or semi-arid region in the world. The Biome is IUCN-recognised as one of the global hotspots of diversity and one of only two hotspots that are entirely arid. However, the location of the mine is at least outside the vegetation areas categorised by experts as priority areas. Nevertheless, habitat destruction and fragmentation are considered as the most significant environmental impacts.               |
| Mine closure                                              | In the EIA, a plan for the decommissioning of the mine is submitted in accordance with the national legislation requirements. Monthly contributions to an insurance policy will be made. The post closure land use is planned as a return to agricultural land suitable for livestock farming.                                                                                                                                                                                                                                                                            |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Community health, safety and security                     | The mine site is located in the Northern Cape Province of South Africa in the Namaqua District Municipality and borders the Western Cape Province to the east and south. The closest settlements to the project site are Stofkraal and Molsvlei >5 km to the east, each with a population of around 500. Other settlements are more than 15 km away. Due to the remote location of the mine site, the risks (e.g. hazardous/radioactive material, impact on air and water quality, noise) to the health, safety and security of the local community is considered as low. |
| Dialogue and engagement with communities and stakeholders | Consultative processes involving 242 separate meetings with all stakeholders and interested and affected parties at local, provincial and national level have been undertaken in the framework of the EIA. According to the company, no material changes were required to be made as a result of these consultations.                                                                                                                                                                                                                                                     |
| Land acquisition and involuntary resettlement             | The target mining area reveals numerous scatters of Middle Stone Age implements. However, after detailed independent scientific investigations, it was determined they are only of limited scientific value and an official permit was obtained for the mining site. Frontier owns the land on which                                                                                                                                                                                                                                                                      |



| ESG category                                | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | the mine will be developed. There are no residents on the land and no resettlement will therefore be required.                                                                                                                                                                                                                                                                                                                                                                                      |
| Occupational health & safety management     | Health impacts related to dust and other pollutants are considered to be low if appropriate OHS management is in place. No further information on OHS management available at this stage.                                                                                                                                                                                                                                                                                                           |
| Workers' rights                             | South Africa scores 79/100 in the Labour Rights Index. No indication of non-compliance with fundamental workers' rights on the project site found.                                                                                                                                                                                                                                                                                                                                                  |
| Gender and diversity                        | No specific information at this stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Local value added and community development | A number of direct and indirect employment opportunities will be created by the proposed development. However, as employment is scarce in the area (unemployment in the nearest town is about 80 %), people may compete for the available jobs to an extent that it may result in conflict between families and communities (closest vs. same municipality). The water pipeline will pass through one small settlement. Discussions about providing access for domestic purposes are still ongoing. |
| <b>Governance</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Legal compliance                            | No indication of any breaches of law found. Mining right has been granted.                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Management practices                        | Development of management policies ongoing due to early stage; no indication of poor management practices so far.                                                                                                                                                                                                                                                                                                                                                                                   |
| Transparency and reporting                  | Member of the Rare Earths Industry Association (REIA) and the European Raw Materials Alliance (ERMA). Listed on the Toronto Stock Exchange main board from 2010-2015.                                                                                                                                                                                                                                                                                                                               |
| Business ethics                             | South Africa scores 41/100 in the corruption perception index. It is not an EITI country. No indication of unethical practices found.                                                                                                                                                                                                                                                                                                                                                               |

Table 27. ESG features of Zandkopsdrift project, South Africa

### 3.18.4 Further reading

AGES (2014): Draft EIA report: Environmental Impact Assessment Report and Environmental Management Programme: Proposed Zandkopsdrift Mine on the Remainder and Portion 2 of the Farm Zandkopsdrift 537, Northern Cape Province.

[https://sahris.sahra.org.za/sites/default/files/additionaldocs/DraftEIA-](https://sahris.sahra.org.za/sites/default/files/additionaldocs/DraftEIA-EMPR_ZandkopsdriftMine%20primo.pdf)

[EMPR\\_ZandkopsdriftMine%20primo.pdf](https://sahris.sahra.org.za/sites/default/files/additionaldocs/DraftEIA-EMPR_ZandkopsdriftMine%20primo.pdf) (accessed 11.12.2023). Final report provided by Frontier.

Deloitte & Touche (2015): Preliminary Feasibility Study in the Zandkopsdrift Rare Earth Element and Manganese By-product Project in the Northern Cape Province of South Africa for Frontier Rare Earths Limited. 245 pages. (accessed 11.12.2023)

Frontier Rare Earths (2023): ZKDR fact sheet. <https://frontierrareearths.com/wp-content/uploads/2023/12/ZKDR-fact-sheet-June-23-1.pdf> (accessed 11.12.2023)



MSA (2014): NI 43-101 Technical Report – Update of Mineral Resource Estimate on the Zandkopsdrift Rare Earth Element (REE) Project, Republic of South Africa. 181 pages. (accessed 11.12.2023)



### 3.19 Zebediela ultramafic Ni-PGE sulphide project (South Africa)

Information as of 02/2024

#### 3.19.1 General project background

|                                    |                                                                                                                                                                                                                        |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodities</b>         | Nickel, PGE (palladium, platinum, rhodium)                                                                                                                                                                             |
| <b>Other commodities</b>           | Copper, cobalt, gold, chromite, iron ore                                                                                                                                                                               |
| <b>Location</b>                    | Limpopo, South Africa; 24°03' S, 28°58' E                                                                                                                                                                              |
| <b>License type</b>                | Mining Right by DMRE: LP30/5/1/2/2 /2/10174MR<br>Three prospecting areas                                                                                                                                               |
| <b>License owner / operator</b>    | Zeb Nickel Corporation (ZNC, public company)                                                                                                                                                                           |
| <b>Contact</b>                     | 837 West Hastings Street, Suite 507, Vancouver,<br>British Columbia V6E 3N6, Canada<br><a href="https://www.zebnickel.com">https://www.zebnickel.com</a><br><a href="mailto:info@zebnickel.com">info@zebnickel.com</a> |
| <b>Project status</b>              | Pre-feasibility                                                                                                                                                                                                        |
| <b>Possible production by 2030</b> | unlikely                                                                                                                                                                                                               |

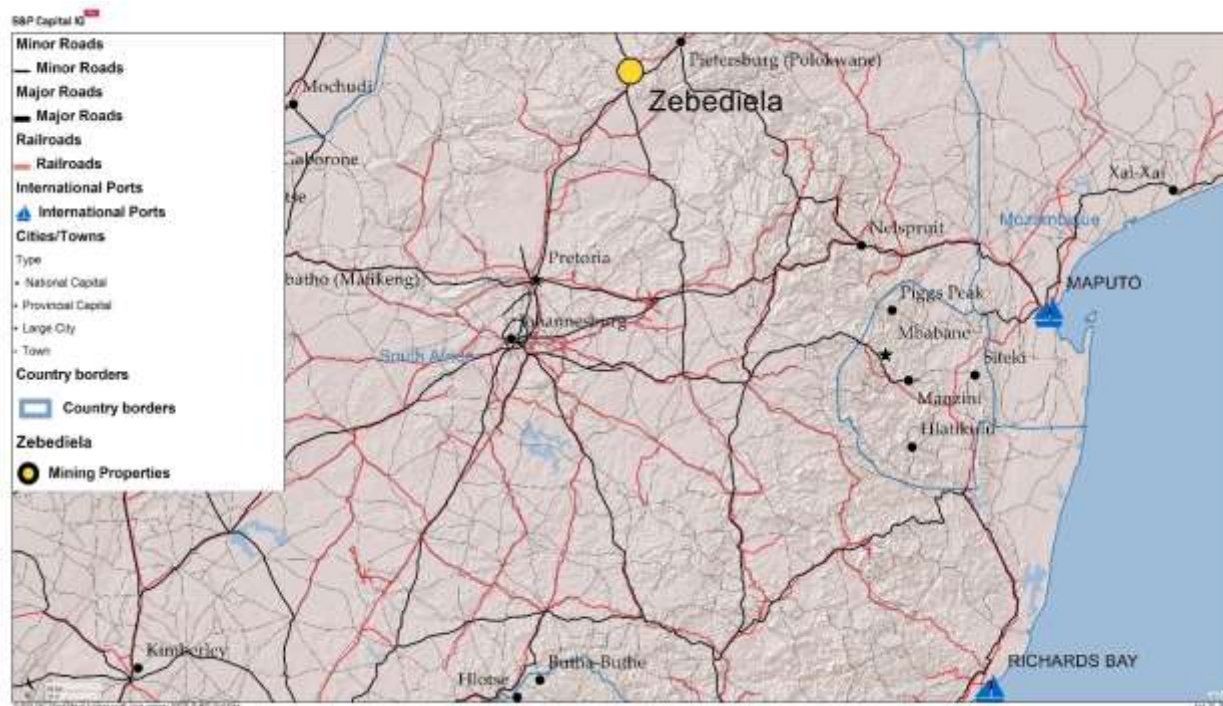
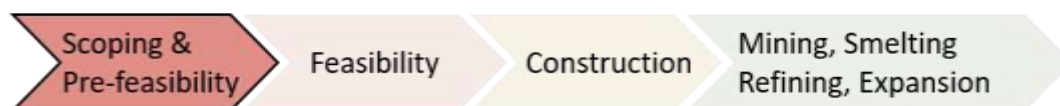


Figure 19. Zebediela project location, South Africa

### 3.19.2 Economic assessment

#### General project background:

South Africa, in particular the Bushveld Igneous Complex (BIC), has an over 100-years PGE mining history. The Zebediela deposit is located in the Northern Limb of the BIC, which is by far the largest PGE resource in the world. The Mining Right Application is held 100% by Lesego Platinum Uitloop (Pty) Ltd. Zebediela. It is a high tonnage, medium to low grade Ni-Cu-PGE deposit, which is divided into two ultramafic ore bodies, Uitloop I and Uitloop II. Both bodies have the potential to host low-grade, disseminated PGE bearing nickel-copper sulphides. Three mineralisation types occur within the project: (i) Ni-Cu-PGE mineralisation hosted by disseminated sulphides and contact-style Ni-Cu-PGE mineralisation in the upper Platreef stratabound mineralised zone, up to 150 m thick; (ii) medium grade nickel sulphides, associated with disseminated sulphidic low-grade, nickel-containing mineralisation, hosted mostly in alternating dunite, serpentized dunite, serpentinite, pyroxenite and harzburgite within the Lower Zone of the Uitloop II ore body; (iii) nickel-rich massive-sulphide bodies within the ultramafic lithologies close to, or on the footwall contact to underlying ultramafic basement rocks. A diamond drilling program of 3,220m, started in 2022 and was completed in 2023. An extended 42,000m-drill campaign is currently in progress and will be completed in 2025.

#### Project description:

|                                                             |                                                                                                                  |
|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                                            | Sulphides and silicates within ultramafic host rocks                                                             |
| Proven mineral Reserves and Resources (NI 43-101 compliant) | 485.4 Mt @ 0.25 % Ni, 2 g/t 4E (Pd, Pt, Au and Rh);<br>inferred resources of 1,115.1 Mt @ 0.25 % Ni and 2 g/t 4E |
| Share of global Ni reserves                                 | <1 % ( <i>USGS estimate global Ni reserves of &gt;100 Mt</i> )                                                   |
| Total resources                                             | 1.6 Bnt @ 0.2 % Ni; 2 g/t 4E                                                                                     |
| Share of global Ni resources                                | 0.2% (USGS est. 102 Mt world Ni resources)                                                                       |
| Annual production                                           | Processing of 20 Mt ore/pa: 30 kt Ni; 250 koz 4E                                                                 |
| Start-up & Life of mine                                     | n.d. / 25 years                                                                                                  |
| Investment – total CAPEX                                    | US\$ 950m in a two-phase program for start of production                                                         |
| Net present value (NPV)                                     | US\$ 1,018m (pre-tax and pre-royalty, at 8 % discount rate)                                                      |
| Share of global Ni production                               | 0.1 % ( <i>USGS estimate global Ni production of 3.3 Mt in 2022</i> )                                            |

#### Mining and processing:

- The project plan comprises the mining and milling of at least 500 million tonnes of mineralised material. It will involve a mechanised open pit mining operation. The pit is planned to be approximately 1,700 m long, 880 m wide and up to 250 m deep. The proposed mining rate is 20 Mtpa using a contractor mining fleet.
- Processing includes crushing and screening, milling and flotation or magnetic separation. The upgrading of nickel and precious metals via froth flotation and magnetite via magnetic separation will be the most economical and viable method. The recovery of all sulphides would

account for a total nickel recovery of up to 62 % in Ni-concentrates, which will have a grade of 16 % nickel. Processing test work as well as mineralogical analyses have shown that the liberated sulphides and the sulphides in the middlings account for only 1.3 % of the total sample mass, but represent an average recovery of 56 % of the Ni and PGE minerals, which can be concentrated by froth flotation. The significant amount of magnetite will also be investigated as a potential by-product of the mine.

- The Zebediela PEA projected a pre-tax and pre-royalty net present value of US\$ 1,018m, an internal rate of return of 25.7 %, and a 3.8 year payback period at an 8 % discount rate. The calculation is based on a nickel price of US\$8.50/lb and a ZAR/US\$ ratio of 8.1. Annual free cash flow was projected to be US\$ 203m.
- Start-up capital expenditures, including CAPEX contingencies, were estimated at US\$ 950m and sustaining capital was estimated at US\$ 58m over the LOM. OPEX were estimated at US\$ 3.35 per pound of recoverable nickel.

#### **BGR assessment and comments:**

- The license area of Zebediela is located only 9 km north-east of Mokopane, a well developed mining town. The project lies directly adjacent to the east of Ivanhoe's Ivanplats (Platreef) mine/project and southeast of Anglo Platinum's Mogalakwena mine. Therefore, the infrastructure is generally well functional and in good condition, such as transport routes and connections for workers including technical and professional services as well as a stable electricity supply. However, further investments in the energy grid as well as in (dust-free) asphalt connecting roads will be necessary.
- The water supply, especially groundwater, for the project could pose a challenge. The competition with the surrounding mines, which already have a significant water consumption is very high, as well as with the surrounding farming communities, which rely on the groundwater in the region. A river diversion of the nearby Rooisloot River is considered. Depending on the final surface infrastructure requirements, this is currently being examined.
- Zebediela is a medium to low-grade, high-tonnage Ni (Cu, Co) and PGE project. The low grade of the deposit poses challenges to the recovery, leading to an average Ni recovery rate of only 56%. However, the total ore resources of 1.6 billion tons are exceptionally high and almost comparable to the neighbouring mines of Mogalakwena and Ivanplats, the world's largest PGE ore resources. The minimum life of mine for Zebediela is 25 years, which could realistically be increased by another 5 to 10 years. This would provide interesting economic opportunities for future regional development.
- The Uitloop ore body occurs on the surface in the Zebediela license area. The resulting open pit method represents a major economic and logistical (also safety-related) advantage over

the Ivanplats project, whose ore body lies at depths between 600 and 700 m. Therefore, faster construction, commissioning and ramp-up can be expected in Zebediela.

- The current ratio of the Rand to the US\$ of around 18 is far away from the expected ratio of 8.1 in the PEA. This would mean that the prices in the PEA are classified as significantly too high. However, since the feasibility study involves international companies whose prices are essentially based on the US dollar, no major differences to the stated prices and the economics of the project are expected due to these fluctuations and the devaluation of the Rand. The Nickel price of US\$ 8.50 per lb is below the price average since 2021, but the nickel price is experiencing pressure since the ramp up of additional capacities in Indonesia.

### 3.19.3 ESG assessment

The current data and information situation is rather sparse, also the project is at early stage. The level of Information until 2021 is acceptable, afterwards detailed information and data on the project are difficult to obtain. The risks for most environmental issues are considered to be generally low with the exception of water related risks which also might affect communities and farming activities. The Limpopo Province, where the project is located, is an area with partly arid conditions and general high water stress. The surrounding farming community relies on the region's groundwater as its only source of water. Also dust emission is a major risk, related to people as well as water needed for dust suppression

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Environmental management                                           | A draft EIA and EMP report was submitted to the Department of Mineral Resources and Energy (DMRE) in November 2020, however early project stage.                                                                                                                                                                                                                                                                                                                                                                                                    |
| Efficient use of energy, renewable energy, GHG emissions reporting | No information about emissions (scope 1 and scope 2) available. An electrical supply from the ESKOM Power Utility (mainly coal-based) is in the planning stage. The construction of a wind farm generating renewable energy is considered.                                                                                                                                                                                                                                                                                                          |
| Water management and consumption                                   | Semi- arid region with low water use. Groundwater supply in the area is limited. A possible river diversion of the Rooisloot River may be considered, depending on final surface infrastructure layout requirements. An integrated Water Use Licence as well as a Water Management License were submitted. Stormwater management will be important to limit impact on the Rooislot river area. Possible contaminated water will be captured and not discharged to the environment. A sludge treatment facility will be constructed to treat sewage. |
| Pollution prevention                                               | The potential for AMD is furthermore expected to be low (low sulphur content, buffering capacity). Water pollution resulting from mining                                                                                                                                                                                                                                                                                                                                                                                                            |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | activities and processing (e.g. flotation chemicals, sewage from thickeners) are among the key infrastructure and property risks identified. A pollution control dam for the plant area and for the overburden facility is planned.                                                                                                                                                                                                     |
| Air quality                                               | Dust emissions from the mining activities but also from vehicle entrained dust from unpaved roads is a major risk. Studies of air quality, heritage, noise and blasting are currently being carried out. In the adjacent Ivanplats and Mogalakwena mines dust extraction and suppression systems have been included to minimise fugitive dust release. Especially in Ivanplats, dust suppression is present on all ROM transfer points. |
| Tailings management                                       | Sufficient suitable land area is available within the mining right licence for any future tailings disposal and mine waste disposal. Four different location alternatives were investigated, particularly from a hydrogeological perspective, for the TSF. The re-processing of the flotation cleaner tailings in close circuit is provided, to ensure maximum recovery.                                                                |
| Waste management                                          | Management of waste rock (construction of storage facilities) is also being taken care of; space is available (see above), but concrete plans are still pending. All remaining solid waste is collected and sorted at the mine's salvage yard; recycling initiatives will be investigated.                                                                                                                                              |
| Hazardous materials management                            | The same as above applies to the storage of hazardous waste. A registered hazardous waste disposal facility is being planned.                                                                                                                                                                                                                                                                                                           |
| Noise and vibration                                       | The risks of noise and vibration are also identified. Waste rock material will be used to build a dam between the mining complex and the local village community.                                                                                                                                                                                                                                                                       |
| Protected areas and biodiversity                          | The Zebediela licence area is located about 7 km south of the Witvinger Natural Reserve and 12.7 south-west of the Persy Fyfe Natural Reserve. Therefore, the mining licence area and also the proposed mining footprint is very close to any of the reserves.                                                                                                                                                                          |
| Mine closure                                              | The Zebediela project will be an open pit mine. Final rehabilitation will be completed within the context of the closure plan stated by ZNC. Former closure costs (Draft EIA 2020) estimated the mine's environmental liability at about R 168 million (Incl. VAT) over an estimated 30 year LOM (scheduled closure).                                                                                                                   |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Community health, safety and security                     | Environmental, Social, and Health Impact Assessment (ESHIA) programme in accordance with national law established. A Social Labour Plan (SLP) was submitted to the Department of Mineral Resources and Energy (DMRE). The Zebediela license area is located northwest adjacent to the settlement area of the town of Mokopane, with around 120,000 inhabitants.                                                                         |
| Dialogue and engagement with communities and stakeholders | There are several villages adjacent to the area of the Project. A database of Interested and Affected Parties has been established and consultation with the relevant authorised representatives from these communities is ongoing. Land access agreements are signed with relevant landowners to allow for prospecting activities to proceed.                                                                                          |



| ESG category                                  | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Land acquisition and involuntary resettlement | Land use agreements are also being concluded in the SLP with the local communities. No relocation of local villages needed and planned.                                                                                                                                                                                                                                                                                                                                  |
| Occupational health & safety management       | To date, there is no information available about planned occupational safety measures on site. No information on related policies / management systems of ZNC.                                                                                                                                                                                                                                                                                                           |
| Workers' rights                               | The SLP has already been submitted to the Department of Mineral Resources and Energy (DMRE) (see above). According to the Labour Rights Index, South Africa currently scores 79/100.                                                                                                                                                                                                                                                                                     |
| Gender and diversity                          | No information available at this stage. No related policy of company published on website.                                                                                                                                                                                                                                                                                                                                                                               |
| Local value added and community development   | The local value proposition is considered to be high. Appropriate skills for mining, processing and engineering will be sourced from the local community. Local development projects planned and approved by the Department of Mineral Resources and Energy (DMRE) include the provision of infrastructure as well as educational support. Royalties and production taxes are related to a nickel price of US\$ 8.50/lb. Annual cash flow was projected to be US\$ 203m. |
| <b>Governance</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Legal compliance                              | Applications for a Water Use Licence and Water Management License have been submitted to the competent authorities and the approvals are still pending. Mining right and Environmental Authorisation submitted.                                                                                                                                                                                                                                                          |
| Management practices                          | DigBee ESG rating of “BB” (level 6 out of 10). Internal environmental, health, safety and technical policy established. However, no reference to related management practices on ZNC website.                                                                                                                                                                                                                                                                            |
| Transparency and reporting                    | ZNC is listed at the Toronto Stock Exchange (TSX:ZBNI). Information for investors, reports on financial accounts and shareholder structure is available. ESG information sparse.                                                                                                                                                                                                                                                                                         |
| Business ethics                               | South Africa scores 41/100 in the corruption perception index; South Africa is not an EITI country. Code of business ethics, anti-bribery, human rights, whistle-blower policies available. No indication of unethical practices found.                                                                                                                                                                                                                                  |

Table 28. ESG features of the Zebediela PGE project, South Africa

### 3.19.4 Further reading

Blue Rhino Capital Corp (2021): Independent NI 43-101 Technical Report on the Zebediela Nickel Sulphide Project. [https://zebnickel.com/wp-content/uploads/2023/07/230712-Caracle\\_ZebNickel-NI43-101-TR-Rev-0.pdf](https://zebnickel.com/wp-content/uploads/2023/07/230712-Caracle_ZebNickel-NI43-101-TR-Rev-0.pdf) (accessed 15.02.2024)

Exigo (2020): ZEBEDIELA NICKEL MINE DRAFT EIA&EMPR LP30/5/1/2/2/10174MR; prepared for Lesego Platinum Uitloop (Pty) Ltd., submitted to the DMRE on November 18, 2020.



## 4 Mining projects

Active mines generate continuous production and usually imply the existence of an economically viable ore deposit. For larger projects with a long mine life (>15 years and up to several decades), it is common that the operator at some point decides on one or multiple stages of mine expansion in parallel to its operation (e.g., upscaling of processing facilities, expanding or developing new pits or underground workings). This may unlock additional ECRM production capacities. A mine's processing facilities may also be modified to recover additional metals of interest, reflecting changing demand patterns (e.g., former tantalum mines now developed as lithium projects). Mines may be temporarily placed under care and maintenance but can then be brought back into production over relatively short time periods (e.g., one year), if enabled by improving market conditions. Note that mining projects with their own associated metal refining facilities are presented in chapter 5.

Projects in the feasibility study stage have a reasonable chance for successful mine development over a relatively short time span (< 5 years) and are therefore included in the category of 'mining projects' of this report. These projects may be of particular interest as potential 'strategic projects' in the EU's critical raw materials act, since they might be expected to the 2030 benchmarks defined therein.

Besides increasing a mine's ECRM output levels, operators or investors may also target improving the ESG performance of existing mines, for instance through improved efficiency, providing a better health and safety environment, managing more environmental impacts, or engaging in community consultations. For example, mine operators increasingly consider options to improve their carbon emission profile by increasing their renewable energy supply, for instance through a local photovoltaics plant, or by electrifying their mine fleet. These ESG-related performance improvements are usually not identified as the primary investment thesis below, but are important to consider nonetheless.

Investing in in feasibility-stage projects or in the expansion or ESG performance improvement of active mines may all be expected to increase the availability of (responsible) mineral production over a relatively short time scale and, in the case of ESG improvements, may also result in improved access to the European market in terms of compliance with certain mineral supply chain regulations. Improving a mine's ESG performance is further critical to avoid local community unrest or regulatory compliance problems in the host country, both of which can interrupt ECRM production from an otherwise economically viable mine.

## 4.1 Balama North graphite (-V) schist project (Mozambique)

Information as of 02/2024

### 4.1.1 General project background

|                                    |                                                                                                                                                                                                                         |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Graphite                                                                                                                                                                                                                |
| <b>Other commodities</b>           | Vanadium                                                                                                                                                                                                                |
| <b>Location</b>                    | Cabo Delgado, Mozambique<br>13°10' S, 38°48' E, 450 – 550 m.a.s.l.                                                                                                                                                      |
| <b>License type</b>                | Mining concession MC11584 (Cobra Plains, 142 km <sup>2</sup> )<br>valid until 2048, Exploration license 5966 (Nicanda Hill<br>and Nicanda West, 185 km <sup>2</sup> ) to be renewed                                     |
| <b>License owner / operator</b>    | Grafex Ltd. (100 % Triton Minerals Ltd.; publ. company;<br>34 % Chinese inv. share in Triton (Jinan Hi-Tech))                                                                                                           |
| <b>Contact</b>                     | 220 St Georges Terrace, Suite 5, Level 3<br>Perth, Western Australia 6000<br><a href="http://www.tritonminerals.com">www.tritonminerals.com</a><br><a href="mailto:info@tritonminerals.com">info@tritonminerals.com</a> |
| <b>Project status</b>              | Feasibility Started                                                                                                                                                                                                     |
| <b>Possible production by 2030</b> | Yes                                                                                                                                                                                                                     |

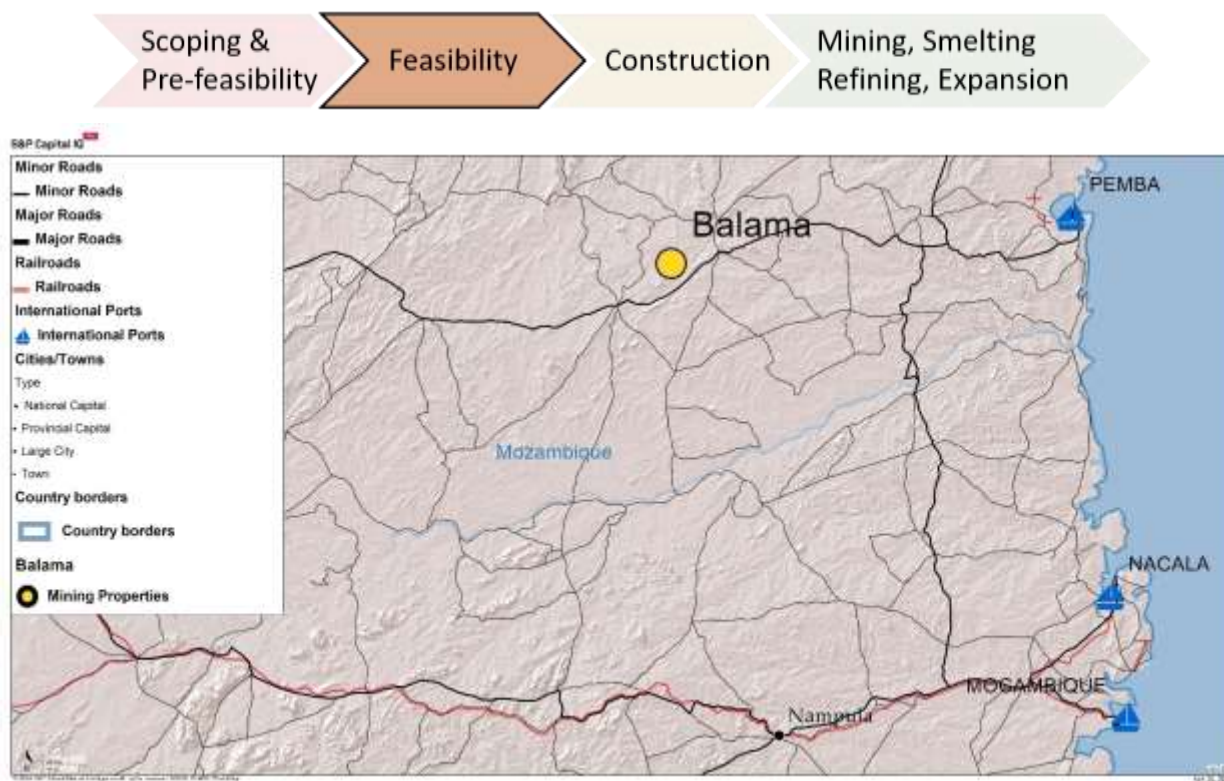


Figure 20. Balama North project location, Mozambique

### 4.1.2 Economic assessment

#### General project background:

The Balama North area has been explored by the current owner Triton Minerals since 2013. It is located some 10 km north of Syrah Resources' high-grade, high-tonnage Balama graphite mine. The graphite mineralisation is hosted by a series of fine-grained graphitic schists underlain and overlain by felsic gneisses within the Neoproterozoic Xixano Complex. The graphitic schists dip 35-40° to the northwest. Graphite mineralisation crops out at surface and has been intersected at downhole depths of up to 429 m below surface. At Nicanda Hills the continuous graphitic schist package extends ~5.7 km, at Cobra Plains ~2 km. Occurrences of vanadium mineralisation is associated with quartz-muscovite schists. The Balama North complex is comprised of the Triton-owned mining concession Cobra Plains and the exploration license for the Nicanda Hills and Nicanda West projects, which was previously owned by Triton but has to be renewed. Since 08/2022, there have been talks between Triton and the Mozambican government about the potential reinstatement of the licence area. Triton is now actively seeking a joint venture partner and investment for Balama North to finalise feasibility studies and advance development.

#### Project description:

|                                    |                                                                                                                                                                       |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Flake graphite                                                                                                                                                        |
| JORC compliant resources           | Nicanda Hill: 1,430 Mt @ 11.1 % TGC, 0.3 % V <sub>2</sub> O <sub>5</sub><br>Cobra Plains: 103 Mt @ 5.2 % TGC<br>Nicanda West: 30 Mt @ 6.6 % TGC                       |
| Share of global graphite resources | 20.3 % ( <i>USGS estimate global graphite resources of 800 Mt</i> )                                                                                                   |
| Share of global vanadium resources | 3.8 % ( <i>USGS estimate global vanadium resources of 63 Mt</i> )                                                                                                     |
| Waste to ore ratio (whole orebody) | low stripping ratios expected due to near-surface operation                                                                                                           |
| Annual production                  | Not estimated yet                                                                                                                                                     |
| Life of mine                       | Not estimated yet                                                                                                                                                     |
| Investment required                | CAPEX for completing feasibility study and mine development<br>not published                                                                                          |
| Net present value                  | Not yet available                                                                                                                                                     |
| Value addition potential           | It could be considered to do further processing, such as<br>mechanical shaping (micronising and spheronising) in<br>Mozambique to produce battery graphite feedstock. |

#### Mining and processing:

- Due to the nature of the mineralisation, conventional open pit methods with low stripping ratios are assumed.
- Graphite processing is expected to include the steps of crushing, grinding and flotation. Preliminary flotation tests on Nicanda Hill samples yielded concentrates with overall grades between 87.2 % and 99.6 % total graphitic carbon (TGC) content, while recoveries ranged from 70.4 % to 92.9 %. Flake size distribution and purity tests demonstrated that ~90 % of the graphite

concentrate flakes are smaller than 75 µm (85.6-96.7 % TGC) and most of the remainder is between 75 and 150 µm (95.4-98.5 % TGC).

### **BGR assessment and comments:**

- The deposit is a high-grade, high-tonnage project with an expected relatively low waste to ore ratio due to the near-surface location of the mineralisation. The current resource estimates, particularly those of Nicanda Hill, suggest a long life of mine. Nicanda Hill's resource estimates indicate significant amounts of contained vanadium that could be extracted as a co-product. It should be noted, however, that more than 70 % of the estimated resources are classified inferred resources and these estimates are significantly less reliable than measured resources or reserve estimates. Resource extensions during the current exploration programme are prospective to the west, east and south and have yet to be evaluated.
- Since 2016, Triton has focussed its project development capacities on its Ancuabe graphite project (~100 km east of Balama North), which was significantly more advanced and therefore considered less risky than the Balama North project. An investment into the Balama North asset at the moment seems to be more risky, as it is not clear, how the operator will advance the project, given the fact that there are more and further developed projects in Mozambique and other countries. On the other hand the project is a good opportunity to get access to a huge high grade graphite project.
- The Balama North Project is located in northern Mozambique, ~240 km west of the Pemba Port and ~30 km west of Montepuez. Due to the company-owned Ancuabe project, existing infrastructure can be used at least between Ancuabe and the Pemba Port. Currently, there is no connection to the national power grid. Syrah Resources' operating graphite project meets its power demand with a diesel power plant and a photovoltaic system in combination with a battery storage system, which would also be conceivable for Triton's assets. Similarly to Syrah Resources' operation, water might be supplied from the Chipempe Dam (~12 km).

### **4.1.3 ESG assessment**

Due to overall rudimentary reporting of Triton, information in several ESG categories were not available. For ESG categories in which a comparison appeared reasonable (in particular management practices and track records) information from the Ancuabe project that is also owned by Triton were used for this assessment. Overall, no major ESG issues which would pose a risk that could not be handled by diligent management and operational practice were identified at this stage of the project. However, this assessment bears a significant degree of uncertainty due to the lack of information and further investigation for verification are recommended.

There have been terrorist attacks since 2017 in Cabo Delgado. In 2019 these insurgencies forced big international projects like Total's LNG project to hold operations. The terrorist groups are still active, but the insurgencies significantly decreased in 2022 and 2023.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Environmental management                                           | No information on general environmental policies on companies website; no detailed information on environmental management available; no reports on any incidents found.                                                                                                                                                                                                                                                                                                      |
| Efficient use of energy, renewable energy, GHG emissions reporting | No information on power demand at this stage of the project; Ancuabe project supplied by photovoltaic plant (1 MW) and diesel generator (8 MW), with plans for grid (82 % hydropower) connection later on dependable on grid development projects.                                                                                                                                                                                                                            |
| Water management and consumption                                   | Area with low water stress, however heavy seasonal rains may occur; no detailed information on hydrology and water demand available at this project stage; competing water usage assumedly not a high risk anticipating realisation of high water recycling rates, however, need for detailed investigation in further studies.                                                                                                                                               |
| Pollution prevention                                               | No specific information on AMD potential for the Balama North deposit available; stated to be moderate at neighbouring Ancuaba project of Triton and the Balama project of Syrah Resources. Flotation technology may imply use of hazardous reagents, in case of graphite flotation usually fuel oil or kerosene are applied. No information on planning of leaching operation onsite to extract V from concentrate; leaching technology would imply use of acids or cyanide. |
| Air quality                                                        | Required mitigation measures needed, also considering distance to settlements; final location and size of operation not defined at this project stage. Widespread dispersion of dust has been reported as an issue of graphite mining in general.                                                                                                                                                                                                                             |
| Tailings management                                                | No information available on required TSF at this project stage; AMD potential will require a secured sealing of the tailings.                                                                                                                                                                                                                                                                                                                                                 |
| Waste management                                                   | No specific information available.                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Hazardous materials management                                     | Flotation technology and use of reagents is considered low risk assuming responsible handling; no specific information on reagents available.                                                                                                                                                                                                                                                                                                                                 |
| Noise and vibration                                                | Required mitigation measures dependable on distance to settlements; final location and size of operation not defined at this project stage.                                                                                                                                                                                                                                                                                                                                   |
| Protected areas and biodiversity                                   | The project is not located in or close to any key biodiversity areas or other designated protected areas. Satellite imagery showing domination of small scale agricultural activities and scattered woodland; negative impact on biodiversity assumed to be low.                                                                                                                                                                                                              |
| Mine closure                                                       | No information on mine closure planning available at this project stage.                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Social and socio-economic issues</b>                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Community health, safety and security                              | Rural area with several smaller settlements and some villages in the vicinity, next major settlements Montepuez (270,000 inhabitants in the                                                                                                                                                                                                                                                                                                                                   |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | district [2017 census]) around 18 km east and Balama (175,000 inhabitants in the district [2017 census]) around 29 km southwest. As the final extent of the mining operations is not known yet a precise assessment on community impact is not possible; management practices related to dust emissions and water sources probably relevant.                                                         |
| Dialogue and engagement with communities and stakeholders | Triton is committed to include local communities into project development; no information on practice at the Balama North project site.                                                                                                                                                                                                                                                              |
| Land acquisition and involuntary resettlement             | The exact area of exploration permit was not available for review for this assessment, a need for resettlement action might be likely considering the number of settlements in the vicinity of the project.                                                                                                                                                                                          |
| Occupational health & safety management                   | OHS policy on company level in place; no further information available.                                                                                                                                                                                                                                                                                                                              |
| Workers' rights                                           | Mozambique scores 71.5/100 in the Labour Rights Index. No indication of any shortcomings on site of Triton found.                                                                                                                                                                                                                                                                                    |
| Gender and diversity                                      | Triton is committed to avoid any form of prejudice; Diversity policy in place. No specific information available.                                                                                                                                                                                                                                                                                    |
| Local value added and community development               | Triton is committed to employ national workers and providing training for skill development. Triton states implementation of CSR strategy and incorporation at the Ancuabe project; CSR strategy not available for review, no specific information on CSR measures available.                                                                                                                        |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                      |
| Legal compliance                                          | Exploration permit granted. No indication of any breaches of law found.                                                                                                                                                                                                                                                                                                                              |
| Management practices                                      | No specific information on management practice available; no indication of any lacks of good practice at the Ancuabe project found.                                                                                                                                                                                                                                                                  |
| Transparency and reporting                                | Listed on ASX; extensive information for investors and reports on financial accounts and shareholder structure available. Alignment pursued with IFC Performance Standards on Environmental and Social Sustainability.                                                                                                                                                                               |
| Business ethics                                           | Mozambique scores 25/100 in the Corruption Perception Index. The project's location in Cabo Delgado is considered a high-risk area (CAHRA), In June 2022, Triton's Ancuabe project was attacked by insurgents killing two security guards (see AllAfrica (2022)). Mozambique is an EITI country. No indication of unethical company practices found; anti-bribery and whistleblower policy in place. |

Table 29. ESG features of Balama North project, Mozambique

#### 4.1.4 Further reading

AllAfrica (2022): Mozambique: Insurgents Surge South – Hit Graphite Mine, Make First Attacks in Nampula, Move Closer to Pemba. <https://allafrica.com/stories/202206230772.html> (accessed 12.03.2024)

Triton Minerals Ltd. (2016): Annual Report for the year ended 31 December 2016.  
[https://www.tritonminerals.com/wp-content/uploads/2018/05/829\\_17\\_04\\_24\\_ANNUAL\\_REPORT.PDF](https://www.tritonminerals.com/wp-content/uploads/2018/05/829_17_04_24_ANNUAL_REPORT.PDF) (accessed: 08.02.2024)

Triton Minerals Ltd. (2024): Company website. <https://tritonminerals.com/projects/balama-north/> (accessed: 08.02.2024)



## 4.2 Balama graphite (-V) schist/gneiss project (Mozambique)

Information as of 01/2024

### 4.2.1 General project background

|                                    |                                                                                                                                                                                                                                      |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Graphite                                                                                                                                                                                                                             |
| <b>Other commodities</b>           | Vanadium (potentially)                                                                                                                                                                                                               |
| <b>Location</b>                    | Cabo Delgado province, Mozambique<br>13°19' S, 38°39' E, 600 – 700 m.a.s.l.                                                                                                                                                          |
| <b>License type</b>                | Mining license 6432C valid until December 2038                                                                                                                                                                                       |
| <b>License owner / operator</b>    | Syrah Resources (public company)                                                                                                                                                                                                     |
| <b>Contact</b>                     | Level 7, 477 Collins St<br>Melbourne VIC 3000 Australia<br><a href="https://www.syrahresources.com.au">https://www.syrahresources.com.au</a><br><a href="mailto:enquiries@syrahresources.com.au">enquiries@syrahresources.com.au</a> |
| <b>Project status</b>              | Operating                                                                                                                                                                                                                            |
| <b>Possible production by 2030</b> | Already producing, but graphite capacity still available;<br>short-term vanadium recovery unlikely                                                                                                                                   |

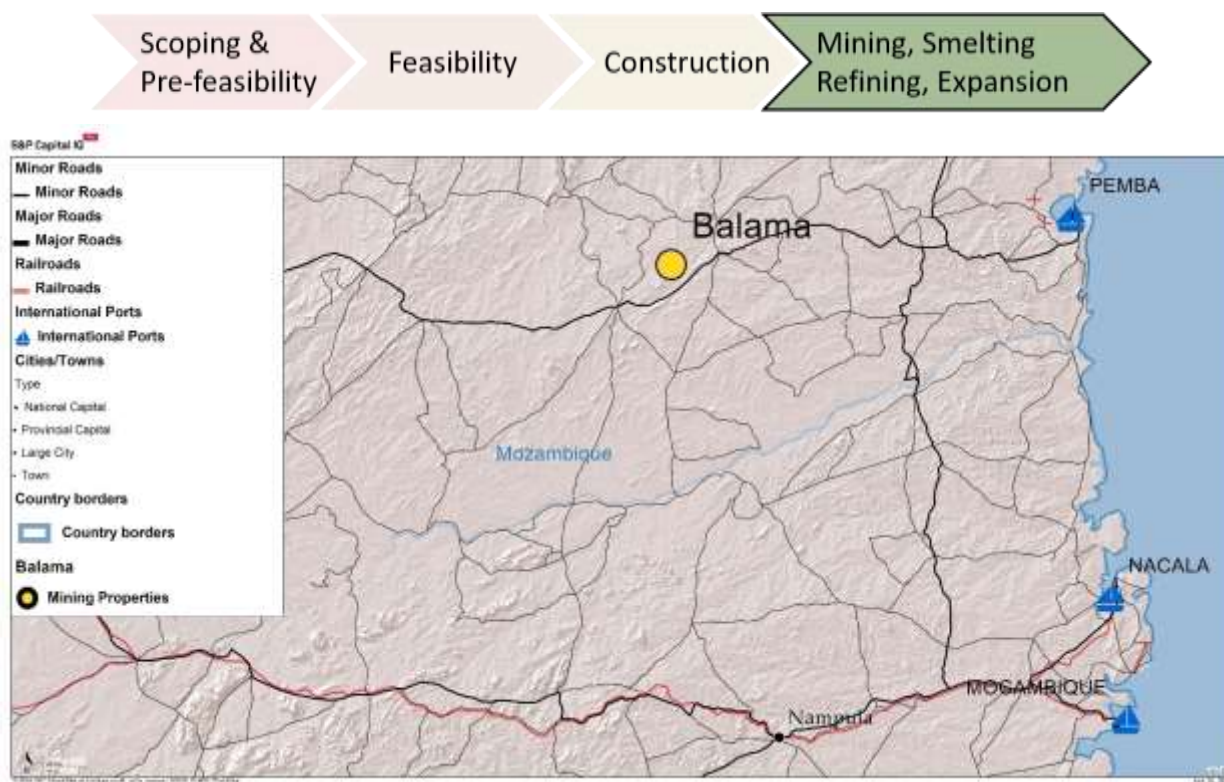


Figure 21. Balama project location, Mozambique

### 4.2.2 Economic assessment

#### General project background:

First graphite production at Balama was reported in 2018. The mine is a high-tonnage operation with a nameplate capacity of 350,000 t of graphite concentrate per year. The project lies within the Neoproterozoic Xixano Complex, which in the Balama region comprises a NNE-trending synform with a core of mafic orthogneisses surrounded by micaceous gneiss and schist, quartzite and marble. Graphitic gneiss and schist, locally enriched in vanadium within the micaceous gneiss unit, dominates the Balama area. Higher-grade graphite mineralisation is hosted by graphitic schists interlayered with lower grade psammities and intruded by volumetrically minor pegmatites. The project contains a significant vanadium resource, which is currently not exploited.

#### Project description:

|                                     |                                                                                                                                                                                                                                                       |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                    | Disseminated flake graphite                                                                                                                                                                                                                           |
| JORC compliant reserves             | 110 Mt @ 16 % C                                                                                                                                                                                                                                       |
| Share of global graphite reserves   | 5.5 % ( <i>USGS estimate global graphite reserves of 320 Mt</i> )                                                                                                                                                                                     |
| JORC compliant resources            | 1,036 Mt @ 12 % C                                                                                                                                                                                                                                     |
| Share of global graphite resources  | 15.4 % ( <i>USGS global graphite resources of 800 Mt</i> )                                                                                                                                                                                            |
| Waste to ore ratio (whole orebody)  | 0.04 over life of mine                                                                                                                                                                                                                                |
| Annual production                   | 2 million t ore throughput yielding 350,000 t graphite concentrate at 94-98 % C                                                                                                                                                                       |
| Life of mine                        | >50 years                                                                                                                                                                                                                                             |
| Investment required                 | US\$ 138m (investment in the past; vanadium resource development costs unknown)                                                                                                                                                                       |
| Net present value (NPV)             | US\$ 1.1bn (10 % discount rate)                                                                                                                                                                                                                       |
| Share of global graphite production | 35 % ( <i>USGS estimate global graphite production of 1 Mt</i> )                                                                                                                                                                                      |
| Value addition potential            | There is brownfield expansion potential for graphite production at Balama. Vanadium in the processed ore (which currently goes into tailings) can be refined into a saleable product ( $V_2O_5$ ) and presents a medium-term, high value opportunity. |

#### Mining and processing:

- Balama has three deposits with the Ativa deposit currently in operation. The ore is processed by crushing, milling, flotation, filtration, drying and screening to produce a concentrate of 94 % to 98 % C. The final product is shipped through the ports of Nacala and Pemba.
- The plant has a capacity of 2 million t ore throughput yielding ~350,000 t graphite per year. It is designed to build up to a recovery of 90 % graphite, with current actual recoveries reported to be <80 %. The average head grade of 16.2 % C over the life of mine.
- The company reported operating costs (C1) of US\$ 430 to 480 per tonne (FOB port of Nacala) for 2022. This is still within an expected range for a high-tonnage operation.

**BGR assessment and comments:**

- The deposit is a high-grade, high-tonnage graphite operation mine with a very low waste to ore ratio of 0.04. The relatively long life of mine of over 50 years can be positive for the development of the region.
- Balama contains a globally significant vanadium resource; a scoping study was completed in 2014. The company plans to advance metallurgical studies and initiate a preliminary feasibility study on the Balama vanadium project.
- The company is aiming to vertically integrate its graphite operations and is currently commissioning its active anode material facility Vidalia in the US with Balama concentrate as feedstock material. The operation of Vidalia is likely to manifest Balama's position as a major graphite producer.

**4.2.3 ESG assessment**

The level of publicly available project information is very good. No major ESG issues were identified that would preclude responsible investment. The operator comprehensively documents its corporate policies and management system, ESG-related information is published quarterly on the company's website. The company is currently undertaking an audit against the Initiative for Responsible Mining Assurance (IRMA) Standard for Responsible Mining at its Balama operations. The project is located in the high-risk area of Cabo Delgado.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Environmental Management                                           | Comprehensive policies and reporting documented; ISO 14001 certified (Health & Safety Management Systems and Environmental Management Systems). No reported incidents concerning non-compliances with environmental laws and regulations found.                                                                                                                                                                                                                                                           |
| Efficient use of energy, renewable energy, GHG emissions reporting | Scope 1 and 2 emissions published quarterly as part of ESG reporting. Operation of an 11.25 MWp solar PV installation combined with an 8.5 MW/MWh battery energy storage system at Balama, to supply an average of 35 % of power requirements, reducing diesel consumption by approx. 35 % and product carbon equivalent emissions by approx. 13 %. Global Warming Potential (Scope 1, 2 & 3) calculated to 0.42 kg CO <sub>2</sub> equivalent per kg graphite. Independent LCA conducted by Minviro Ltd. |
| Water management and consumption                                   | Water stress considered to be low. Raw water for mining and processing operations is sourced from Chipembe Dam and borewater holes within the licence area. The current water licence permits withdrawal of 2 million m <sup>3</sup> /a from Chipembe Dam, water withdrawal (12/23) around 0.5 million m <sup>3</sup> /a. Collection of rainwater. Ongoing focus on recycling tailings water and reducing withdrawal from raw water sources. A water recycling and                                        |

| ESG category                            | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         | purification system has been installed reducing the consumption of single use plastic bottled water. Potential impact on groundwater from the TSF as well as from acid mine drainage had been identified.                                                                                                                                                                                                                           |
| Pollution prevention                    | Moderate potential for AMD formation from waste rock dumps and tailings which could result in leachate water with low pH and increased metal contents; high concentrations of U, Sr, Se and Rb in the graphite zone were also found to be potentially radioactive posing a health risk. With mitigation measures in place the impact can be reduced to low. Drainage monitoring is carried out, especially during the rainy season. |
| Air quality                             | Widespread dispersion of dust has been reported as an issue of graphite mining in general. Air quality management procedure and continuous monitoring systems in place. A meteorological station is located in the project area, no settlements on license area.                                                                                                                                                                    |
| Tailings management                     | The TSF has been classified as a high hazard dam. The company states to have tailings storage facility management aligned with ICMM's new Global Industry Standard on Tailings Management. Installation of bituminous geomembrane installed at Tailings Storage Facility to prevent seepage losses and protect groundwater resources. Regular monitoring conducted.                                                                 |
| Waste management                        | Company committed to waste hierarchy approach (reduce, reuse, recycle). Waste rock dump stockpiles lined with bituminous geomembrane. Waste management systems in place. Current initiatives include composting of organic waste; non-hazardous and hazardous waste disposal methods and volumes monitoring; Waste management education campaigns and awareness-raising sessions conducted regularly.                               |
| Hazardous materials management          | General risk from potentially hazardous process chemicals is rated as high thus adequate management needed. Hazardous waste management procedures in place with training conducted regularly. Hazardous waste managed by external third party.                                                                                                                                                                                      |
| Noise and vibration                     | Increase traffic frequencies through villages had been identified as high significance with low mitigation potential. The company is currently undertaking an audit against the IRMA Standard for Responsible Mining including environmental responsibilities including noise and vibration.                                                                                                                                        |
| Protected areas and biodiversity        | Most of the area agricultural use with low sensitivity; some woodlands and riparian areas with higher biodiversity values; project is not located in or close to a key biodiversity area. The site is an active mining area; expected biodiversity impacts are generally low.                                                                                                                                                       |
| Mine closure                            | Acid mine drainage poses a permanent risk of severe impacts after closure unless adequate precautions and long-term maintenance programmes are in place; Mine closure and rehabilitation plan in place. Provisions are made on a progressive basis; scheduled closure costs of US\$ 17m.                                                                                                                                            |
| <b>Social and socio-economic issues</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Community health, safety and security   | Local town of Balama approx. 13 km from mine site along with further settlements surrounding the licence area. The nearest community is Ntete at 8 km away. Potential negative impacts from the mine on local communities are considered low risk.                                                                                                                                                                                  |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dialogue and engagement with communities and stakeholders | Structured and continuous dialogue with local communities in place. Existing Local Development Agreement with Mozambican Government across a number of key areas such as education, training and local employment; health promotion and awareness; youth and leadership development;; agricultural/livelihood development; food/nutrition and water security; maintenance of cultural heritage; and development of vulnerable people.                   |
| Land acquisition & involuntary resettlement               | Balama is an operating mine. There are no settlements or cultural heritage sites on the license area.                                                                                                                                                                                                                                                                                                                                                   |
| Occupational health & safety management                   | Professional management and OHS measures on site, OHS policy in place, ISO 45001 certified. OHS Performance: 0 fatalities to date and 0 lost time injuries since 2021.                                                                                                                                                                                                                                                                                  |
| Workers' rights                                           | Mozambique scores 71.5/100 in the Labour Rights Index. Relevant policies in place. 41 % local employees. Ongoing capacity building of local communities through professional training programs in work readiness, health & safety awareness and mechanical and electrical maintenance.                                                                                                                                                                  |
| Gender and diversity                                      | Share of women in the workforce: 33 % board of directors, 33 % leadership team, 18 % at Balama and 20 % total Syrah Workforce. The company has an ongoing commitment to training and graduating 500 community members in 5 years at a target of 30 % female participation.                                                                                                                                                                              |
| Local value added and community development               | Local value contribution considered generally high. Local (Balama) and national (Mozambican) employees at 41 % and 91 %, respectively. US\$ 4m invested in community development since 2017, including ongoing capacity building of local communities through professional training programs and large-scale community development projects such as Balama Health Centre, Chipembe Primary School and a Wholesale Central Market at Balama town.        |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Legal compliance                                          | Relevant policies in place, reviewed annually and all employees trained in their application biennially. No indication of any breaches of law found.                                                                                                                                                                                                                                                                                                    |
| Management practices                                      | Comprehensive and structured information on ESG policies and management. ISO 45001 certified. The company has established a project team to align Balama TSF with ICMC standards.                                                                                                                                                                                                                                                                       |
| Transparency and reporting                                | Listed on the Australian Stock Exchange; extensive information for investors and reports on financial accounts and shareholder structure available. The company remains committed to pursuing alignment with leading practice ESG frameworks including GRI, ICMC, SDGs, IRMA and IFC Performance Standards on Environmental and Social Sustainability.                                                                                                  |
| Business ethics                                           | Mozambique scores 25/100 in the Corruption Perception Index. The project's location in Cabo Delgado is considered a high-risk area (CAHRA), In June 2022, attacks temporarily affected the transport of graphite from the mine. Mozambique is an EITI country. No indication of unethical company practices found. Financial accounts according to stock listing requirements; company with registered offices in Australia, Dubai, Mozambique and USA. |

Table 30. ESG features of Balama project, Mozambique

#### 4.2.4 Infrastructure assessment

##### Potential Investment Needs:

- **Railway Enhancements:** Investment opportunity to link the Balama region with the port towns of Pemba and Nacala. Both rail lines would be estimated at costs of US\$ 255m – 290m (Pemba) and US\$ 489m – 556m (Nacala).
- **Renewable Energy Ventures:** Investment opportunity to expand solar energy supply (e.g., BESS, Gildemeister solar park) for Balama in order to reduce dependence on diesel power stations.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | Located in Mozambique's Cabo Delgado province, Syrah's Balama Graphite Operation is situated 7 km from the town of Balama and approximately 260 km by road west from the port town of Pemba. The mine has been in production since 2017 and has since heavily developed the local infrastructure. The Balama region is host to multiple ECRM deposits, including Triton Minerals' graphite-vanadium deposit (Balama North) and Battery Minerals' Balama Central Graphite Project.                                                                                                                                                                  |
| Transport                 | The project is readily accessible by the N1 and N14 (sealed) national highways. The well maintained R768 non-sealed road diverts from the N14 and leads approximately 5 km to the project site. The N14 stretches approximately 160 km to the N1 junction, from where freight trucks can continue east for 96 km towards the port of Pemba or deviate south towards the port of Nacala (~330 km via N12). Inefficiencies in transport such as narrow roads and heavy traffic cause logistical lag times.                                                                                                                                           |
| Airport                   | Pemba national airport is the closest commercial airport to the Balama region (260 km). It consists of a 1.8 km asphalt runway. Nacala international airport boasts a slightly larger capacity and consists of a 3.1 km asphalt runway. There is a potential expansion/modernisation investment opportunity, however aviation infrastructure appears less vital than land and water infrastructure.                                                                                                                                                                                                                                                |
| Rail access               | No existing railway infrastructure from the deposit location to the port towns of Pemba or Nacala. East-west trending rail infrastructure makes up the "Nacala Integrated Logistics Corridor", connecting the port with Moatize via Malawi. Investment opportunities exist to connect the ECRM-rich region of Balama by rail to the Ports of Pemba (ca. 260 km) and Nacala (ca. 500 km). Single narrow-gauge track, for example, costs approximately US\$ 1 million per km, while standard gauge track comes in at US\$ 1.1 million per km. Both rail lines would be estimated at costs of US\$ 255m – 290m (Pemba) and US\$ 489m – 556m (Nacala). |
| Port                      | The port of Pemba is the nearest port to the Balama North Project and is accessible by road transportation only. The port is managed by Mozambique Ports and Railways (CFM Norte) and has in recent years undergone modernisation. Current container capacity is approximately 27,000 TEUs annually. The container storage facility accommodates up to 1,800 m <sup>2</sup> of bagged cargo (breakbulk) and 15,000 m <sup>2</sup> of general cargo (container). The port has one dry-cargo berth with a depth ranging between 7 m and 8 m, accommodating ships with a maximum draught and length of 8 m and 120 m, respectively.                   |



|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | The larger port of Nacala is located approximately 490 km from Balama and is accessible by road transportation only. The port is managed by Mozambique Ports and Railways (CFM Norte) and has in recent years undergone substantial rehabilitation/modernisation. Container handling capacity was 100,000 TEUs annually in 2022, with the ambition of increasing to 252,000 TEUs upon completion of expansion works. Similarly, storage capacity is expected to increase from 5,000 TEUs to 13,000 TEUs. The port has a twin container berth and four cargo berths accommodating ships with a maximum draught and length of 14 m and 200 m, respectively, and a maximum of 80,000 dwt. |
| Energy       | An 11.25 MWp photovoltaic array, comprising 20,832 solar modules, has been combined with an 8.5 MW battery energy storage system and automated power management system at Syrah's Balama Graphite Operation. The project is powered in hybrid form with the 15.4 MW on-site diesel power station (7 x 2.2 MW generators). Installation of a 33 kV overhead power line and 500 kVA, 250 kVA, and 50 kVA transformers at the project site was completed during the pre-construction phase, allowing power to be sourced from the national grid upon the fifth year of operations.                                                                                                        |
| GHG emission | To curb CO <sub>2</sub> emissions and reduce power grid dependencies, investments are directed towards renewable energy sources like solar farms. Projects such as the BESS and the Gildemeister solar park enhance this initiative. Estimated solar plant costs for 2021 are between US\$ 580 to 870 per kWp, expected to decrease in the future. The required investment is around US\$ 4m to 6.1 m for about 7,000 kWp excluding annual maintenance costs. Gildemeister's solar park, with a capacity of 6.5 MWp, will produce approximately 14 GWh (~50,400 GJ) of electricity annually.                                                                                           |
| Water        | The approximately 2 million m <sup>3</sup> /a of water needed for the project is sourced from the Chipembe Dam, which is located 12 km from the Balama Project site. The dam has a total capacity of 25 million m <sup>3</sup> . Infrastructure comprises of a pump station at Chipembre Dam, a 12 km pipeline, and a high-density polyethylene lined storage pond at site.                                                                                                                                                                                                                                                                                                            |

**Table 31. Infrastructure assessment of Balama project, Mozambique**

#### 4.2.5 Further reading

IRMA (Initiative for Responsible Mining Assurance) Ongoing Audit of Balama Graphite Operation: <https://connections.responsiblemining.net/site/174>

Mining Technology (2019): Balama Graphite Project. <https://www.mining-technology.com/projects/balama-graphite-project/> (accessed 27.11.23)

Syrah Resources (2015): ASX Announcement - Syrah Finalises Balama Graphite Feasibility Study and Declares Maiden Ore Reserve. <https://announcements.asx.com.au/asxpdf/20150529/pdf/42yw7f27bc6j4d.pdf> (accessed 24.11.23)

Syrah Resources (2023): ASX Announcement – Quarterly Activities Report. <https://company-announcements.afr.com/asx/syr/19d8a861-6c6a-11ee-bd13-9634f54a48ff.pdf> (accessed 27.11.23)



Syrah Resources (2023): Balama Graphite Operation - Cabo Delgado Province, Mozambique.  
<https://www.syrahresources.com.au/our-business/balama-graphite-operation> (accessed 24.11.23)

Syrah Resources Quarterly Sustainability Reports available on the company's website:  
<https://www.syrahresources.com.au/Sustainability/reports?tab=Sustainability>

### 4.3 Bisie vein-hosted Sn project (DR Congo)

Information as of 11/2023

#### 4.3.1 General project background

|                                    |                                                                                                                                                                                                                                                                                  |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Tin                                                                                                                                                                                                                                                                              |
| <b>Other commodities</b>           | Copper, lead, zinc, silver                                                                                                                                                                                                                                                       |
| <b>Location</b>                    | North-Kivu, Dem. Rep. Congo<br>1°2' S, 27°44' E, 600 – 850 m.a.s.l.                                                                                                                                                                                                              |
| <b>License type</b>                | Mining permit PE 13155 (129 km <sup>2</sup> ), exploration permits PR 10346; PR 5266; and PR 5267 (260 km <sup>2</sup> )                                                                                                                                                         |
| <b>License owner / operator</b>    | Alphamin Bisie Mining SA (ABM) owned by 84.14 % Alphamin Resources Corp. (publ. comp.), 10.86 % Indl. Dev. Corp. (SA gov.), 5 % DRC gov.                                                                                                                                         |
| <b>Contact</b>                     | Perrieri Office Suites                                                                                                                                                                                                                                                           |
| Direct contact established: No     | Office Block C, C2-302, Level 3, Suite 1, La Croisette<br>Grand Baie, Rivière du Rempart 30517, Mauritius<br><a href="https://www.alphaminresources.com">https://www.alphaminresources.com</a><br><a href="mailto:info@perrieriitsolutions.com">info@perrieriitsolutions.com</a> |
| <b>Project status</b>              | Production – operating, expansion                                                                                                                                                                                                                                                |
| <b>Possible production by 2030</b> | Yes, although more realistic for a smaller expansion                                                                                                                                                                                                                             |



Figure 22. Bisie project location, DR Congo

### 4.3.2 Economic assessment

#### General project background:

Tin-bearing gossans were discovered at Bisie in 2002 and soon became the focus of large-scale and artisanal small-scale mining operations. The Bisie tin mine comprises the Mpama North mine (in operation), the Mpama South development project and the Bisie Ridge exploration target. Mpama North and South are believed to be a single deposit dissected by a cross cutting NE-SW fault zone. The Bisie tin (cassiterite) mineralisation is underlain by Kibaran Belt lithologies and hosted within veins by Upper Mesoproterozoic schists and phyllites, which were intruded by different generations of granites (potential source of tin). Tin vein mineralisation is accompanied by copper, lead and zinc mineralisation in locally significant concentrations, together with silver. The main tin-bearing zone is ~9 m thick at Mpama North and ~7 m at Mpama South. A compelling maiden resource estimate for Mpama South led ABM to decide the development of Mpama South without a formal feasibility study. With the expansion into Mpama South, ABM expects annual tin production to increase by 60 % to 20,000 tonnes from 2024. The owner seeks investment for on-site infrastructure and the construction of a second processing plant.

#### Project description:

|                                    |                                                                                                                                             |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Granite-related, vein-hosted tin deposit                                                                                                    |
| NI 43-101 compliant Reserves       | 2.6 Mt @ 4.64 % Sn (Mpama North)                                                                                                            |
| Share of global tin reserves       | 2.6 % ( <i>USGS estimate global Sn reserves of 4.6 Mt</i> )                                                                                 |
| NI 43-101 compliant resources      | 9.8 Mt @ 3.54 % Sn (Mpama North and South)                                                                                                  |
| Share of global tin resources      | 4.6 % ( <i>BGR estimate* global Sn resources of 7.5 Mt</i> )                                                                                |
| Waste to ore ratio (whole orebody) | ~1 (Mpama South)                                                                                                                            |
| Annual production                  | Pre-expansion: 12,500 t of contained Sn<br>Post-expansion: 0.9 Mt of ore, 20,000 t of contained Sn                                          |
| Life of mine                       | 13 years (planned 20+)                                                                                                                      |
| Investment required                | US\$ 113m (referring to Mpama South expansion for start of production)                                                                      |
| Net present value (NPV)            | US\$ 402m (as of 2019; based on tin price of US\$ 17,300/t and a discount rate of 8 %)                                                      |
| Share of global tin production     | 4.0 % (pre-expansion, recovery 78 %)<br>6.5 % (post-expansion, recovery 78 %)<br>( <i>USGS estimate global Sn production of 310,000 t</i> ) |

#### Mining and processing:

- At Mpama North, underground mining methods employing long hole drilling and blasting methods to excavate the ore before backfilling the open stopes with waste rock. The trucks haul ore to the surface and waste to either the waste dump area on surface or into a stope void, when sufficient stope voids are available for waste tipping.
- The Mpama South mining plan envisages an annual production of 7,500 t of contained tin with a relatively low average waste to ore ratio of ~1.

- The processing plant at Mpama North has the capacity to process ~460 kt/a of ore referring to 12-13 kt/a of contained tin in concentrate. Tin is concentrated via crushing, screening, jigging, milling, spiral classification, shaking tables, flotation (sulphide removal) and magnetic separation to produce a final tin concentrate with a grade of 62 % tin. The tin recovery rate was improved from 75 % in 2021 to 78 % in 2022. With the expansion into Mpama South, ABM plans to construct a second processing plant, identical to the first one with minor improvements to better treat the lower grade ore from Mpama South and to improve on inefficiencies in the existing plant. The new processing plant is planned to process ~468 kt/a of ore referring to 7.5 kt/a of contained tin in concentrate.
- Due to the similar mining and processing conditions, operating expenditures for Mpama South are expected to be identical to those for Mpama North reported to US\$ 14,057/t of tin sold at a tin price of US\$ 40,000/t.

#### **BGR assessment and comments:**

- The deposit is a high-grade, high-tonnage operation with a relatively low waste to ore ratio of ~1. The relatively long life of mine (planned >20 years) can be positive for the development of the region. ABM holds a prospective exploration licence. In addition to Mpama South, which has not yet been fully explored, the first of the company's six priority areas on Bisie Ridge (13 km long) have been drilled targeting new discoveries. ABM's applications for silver, copper, lead and zinc on both PR 5266 and PR 10346 licences were accepted and yield potential for future by-product revenues.
- In recent studies, ABM assumes high tin prices of US\$ 30,000/t and in some studies US\$ 40,000/t for its economic assessment. In contrast, the average tin price for the last 5 years was only US\$ 25,000/t. A more conservative price of US\$ 20,000 to US\$ 25,000 is recommended.
- Although the operating costs at Mpama South may be identical to those at Mpama North, the lower tin grades at Mpama South result in a 40% lower tin contained in concentrate for the same plant feed and suggest that the all-in sustaining costs are higher than at Mpama North.
- ABM has an offtake agreement with Gerald metals SA for its tin concentrates. The agreement is for a five-year period for 100 % of production at a minimum tin content of 60 % terminating in August 2024.
- The Bisie tin project is located ~180 m NW of Goma and ~60 km NW of Walikale and can be accessed by road (N3) from Kampala (Uganda) via Kisangani or by airplane from Goma. The main ports available to the project are Mombasa in Kenya and Dar es Salaam in Tanzania. Water is supplied via springs and rivers. Power is supplied via diesel generators.

### 4.3.3 ESG assessment

Alphamin Bisie Mining (ABM) has received all the approvals for mining under the appropriate policies and legal framework within the DRC. The Environmental and Social Impact study and the Environmental and Social Management Plan are approved in accordance with the mining codex. There is a five-yearly update requirement, however ABM is planning to execute some material changes at the mine site for the development of the Mpama South mine during 2022/23 and is proactively updating the current ESMP. ABM carries out an environmental audit every two-years. Acid mine drainage is a potential risk and might need adequate monitoring and management.

| ESG category                                                                                             | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Environmental management                                                                                 | No general company information on environmental management publicly available. Technical reports (website) refer to environmental management plan as part of licensing procedure as well as external compliance audits every two years and independent quarterly internal performance assessments to monitor progress against the Environmental and Social Management commitments.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Efficient use of energy, renewable energy, GHG emissions reporting                                       | Power is supplied from a diesel power station at 400V distribution voltage with 5 x 1.2MW generators, including one standby unit. Peak power consumption occurs during year 4, calculated at 19.314 MWh This corresponds to about 15.000 t of CO <sub>2</sub> /a. At ¾ load the diesel consumption of the 4 generators is abt. 1000 l/hr.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Water management and consumption                                                                         | The operation is located in a net water surplus climate. To minimise the volume of noncontact surface rainfall run-off reporting to the TSF or operational areas, water diversion channels and ditches were constructed. The preliminary water balance for the site indicates that there is a surplus of contact water that will require discharge to the environment. Sewerage is collected in tanks and transported to the sewerage treatment plant where it is treated to meet the DRC discharge limits before it is discharged to the environment. Sludge from the treatment plant is removed and disposed of at the TSF or used for rehabilitation medium. The water stress at the mining location and the surroundings is considered as low. Rather, a surplus of water can be expected. A stormwater dam has been constructed for a 1:20 year event, even for low risk dams international best practice usually refers to 1:100 year event, for higher risk 1:1000 year event. ABM uses wells for the fresh water supply. Sewerage is collected in tanks and these are regularly emptied and transported to the treatment plant. The treated effluent is discharged to the environment. Sludge from the treatment plant is removed and disposed of at the TSF or used for rehabilitation. The water stress at the mining site is considered low. |
| Pollution prevention  | Geochemical studies and groundwater modelling have identified the mining excavations, TSF and waste rock dump as potential sources of AMD and ground water impacts (e.g. heavy metal contamination) an ESIA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| ESG category                            | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         | amendment as well as AMD tests are reported for 2022, results (not available) should provide suitable management and monitoring guidance.                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Air quality                             | ABM claims that it is in line with Article 466 of the Regulations. ABM is monitoring air quality and dust to demonstrate the efficacy of the mitigation measures in use at the mine.                                                                                                                                                                                                                                                                                                                                                                                             |
| Tailings management                     | TSF operations do not generate dust, as it is a wet dam. Management continues to maintain measures to prevent and manage this risk. Upon closure, the TSF will be capped and rehabilitated to prevent erosion and dust generation. The failure risk of the TSF is being managed as part of the ongoing tailings dam management system and subject of annual independent audits. There are no communities or infrastructure in the tailings dam zone of influence of relevance for the risk management for the TSF is the storm water management and the potential to create AMD. |
| Waste management                        | Residues requiring storage are: Waste rock from the underground mining works, slurry tailings (<1 mm) and coarse, dry tailings (Jig Tailings) (1-10 mm). ABM tracks all inputs into the mine through the ICPE declaration (DRC taxation requirement). This informs the waste management procedure, which provides guidelines for reduction of waste, re-use, the management of waste streams, recycling of metals and oil, and the operation of a landfill and an incinerator/distillation complex                                                                               |
| Hazardous materials management          | See above: general waste management.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Noise and vibration                     | The residents adjacent to the project area could be affected by noise, and vibrations generated from daily blasting. This is mitigated by using standard industry practice.                                                                                                                                                                                                                                                                                                                                                                                                      |
| Protected areas and biodiversity        | The site is predominantly evergreen, tropical, wet primary forest, surrounded by active and abandoned farms. There are many endemic species, and the project area is near-natural. The mining area is not part of a key biodiversity area but the mine is only 15 km from Maiko National Park that is a site for the conservation of the African forest elephant, eastern chimpanzee and the endemic aquatic genet.                                                                                                                                                              |
| Mine closure                            | ABM is providing for rehabilitation (operational costs) and mine closure and carries a future cost provision of US\$ 8.5m on the balance sheet (2022), which is supposed to be sufficient to meet good practice standards. Special attention should be given to AMD management as potential longterm impact.                                                                                                                                                                                                                                                                     |
| <b>Social and socio-economic issues</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Community health, safety and security   | ABM conducted a Project-Affected Community study in order to find out, which community could be affected by the project either from primary (i.e. direct) or secondary economic or social impacts. Vector-related diseases (such as malaria), and communicable diseases like TB were considered as being a high risk to the health of the communities.                                                                                                                                                                                                                           |
| Dialogue and engagement with            | Previous socio-economic work identified numerous towns and villages along major road networks, within a demarcated zone of influence that may be affected indirectly by the mine. The ABM Community Commitment                                                                                                                                                                                                                                                                                                                                                                   |



| ESG category                                  | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| communities and stakeholders                  | Register was agreed and signed in 2021. It defines ABM's geographical impact area/ social zone of influence. Community engagement is ongoing through the Lowa Alliance, which involves regular meetings with communities.                                                                                                                                                                                                                                   |
| Land acquisition and involuntary resettlement | No information available. The mining zone is sparsely populated. Being on the periphery of the current exploration and mining area, Manoire village is considered most directly affected by virtue of being the only settlement close to the mine site. Scattered ASM are reported throughout the broader area. There are no world heritage sites close to the mining project.                                                                              |
| Occupational health & safety management       | OHS risks are related to the mining and processing operation. No further information available                                                                                                                                                                                                                                                                                                                                                              |
| Workers' rights                               | According to the Labour Rights Index in the DRC only limited access to decent work is found. No detailed information available.                                                                                                                                                                                                                                                                                                                             |
| Gender and diversity                          | No information available                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Local value added and community development   | According to the Extractive Sector Transparency Measures Act, ABM has to annually report its payment to the government. For 2022 ABM made total payments of about US\$ 7m to the central government, US\$ 2.3m to the Province of North Kivu, US\$ 1.3m to the Sector of Wanyanga, about US\$ 1m to the mining fund for future generations and US\$ 2.3m for various community projects. ABM states that it sources from local suppliers wherever possible. |
| <b>Governance</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Legal compliance                              | ABM claims that it is compliant with applicable laws and has all relevant licenses. The Bisie Tin Complex is located on the mining permit PE 13155.                                                                                                                                                                                                                                                                                                         |
| Management practices                          | ABM reports on investor relevant topics, including Dodd Frank act policies, and has established a supply chain policy as well as traceability system, it holds ICGLR regional certificate that assesses OECD Due Diligence compliance                                                                                                                                                                                                                       |
| Transparency and reporting                    | Compliant with the EITI requirements for reporting. The registered head office is in Mauritius. Alphamine Resources is listed on the TSX Venture Exchange and the Johannesburg Stock Exchange AltX.                                                                                                                                                                                                                                                         |
| Business ethics                               | Location in conflict-affected and high-risk areas (CAHRA); ABM has published supply chain due diligence policy according to OECD and established a whistleblowing mechanism. Corruption is high, Corruption Perception Index score of DRC 20 out of 100 (2022); its rank is 162 of 180 countries investigated.                                                                                                                                              |

Table 32. ESG features of Bisie project, DR Congo

#### 4.3.4 Further reading

Alphamin Resources Corp. (2022): 03 Aug Alphamin announces updated mineral resource and mineral reserve estimates and life of mine schedule for Mpama North tin mine.

<https://www.alphaminresources.com/2022/08/03/alphamin-announces-updated-mineral->



[resource-and-mineral-reserve-estimates-and-life-of-mine-schedule-for-mpama-north-tin-mine/](#)  
(accessed: 29.11.2023)

Alphamin Resources Corp. (2023a): 13 Feb Alphamin announces successful infill drilling at Mpama South with increase in both resource confidence and mineral resources.

<https://www.alphaminresources.com/2023/02/13/alphamin-announces-successful-infill-drilling-at-mpama-south-with-increase-in-both-resource-confidence-and-mineral-resources/>  
(accessed: 29.11.2023)

Alphamin Resources Corp. (2023b): Investor presentation Q2 2023 28 August 2023.

[https://www.alphaminresources.com/wp-content/uploads/2023/08/ALPHAMIN\\_Q22023.pdf](https://www.alphaminresources.com/wp-content/uploads/2023/08/ALPHAMIN_Q22023.pdf)  
(accessed: 29.11.2023)

Alphamin Resources Corp. (2023c): 09 Oct Alphamin announces Q3 operational and financial update/ Mpama South development progress.

<https://www.alphaminresources.com/2023/10/09/alphamin-announces-q3-operational-and-financial-update-mpama-south-development-progress/> (accessed: 29.11.2023)

Bara Consulting (Pty) Ltd. (2022): Updated technical report for the Bisie tin complex North Kivu province Democratic Republic of Congo. Prepared for Alphamin.

<https://alphaminresources.com/wp-content/uploads/2022/04/Alphamin-Bisie-Tin-Complex-NI-43101-Technical-Report-22-April-2022.pdf> (accessed: 29.11.2023)

## 4.4 Epanko flake graphite project (Tanzania)

Information as of 04/2024

### 4.4.1 General project background

|                                    |                                                                                                                                                                                                                         |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Graphite                                                                                                                                                                                                                |
| <b>Location</b>                    | Morogoro, Tanzania<br>8°43' S, 36°40' E, 400 – 1300 m.a.s.l.                                                                                                                                                            |
| <b>License type</b>                | Mining License ML548/2015<br>Special Mining License (18.9 km <sup>2</sup> ) applied                                                                                                                                     |
| <b>License owner / operator</b>    | Duma TanzGraphite Ltd. (84 % EcoGraf Ltd., public company; 16 % Tanzania gov.)                                                                                                                                          |
| <b>Contact</b>                     | 18 Richardson Street, Level 3<br>West Perth, Western Australia 6005, Australia<br><a href="https://www.ecograf.com.au/">https://www.ecograf.com.au/</a><br><a href="mailto:info@ecograf.com.au">info@ecograf.com.au</a> |
| <b>Project status</b>              | Preproduction - Construction Planned                                                                                                                                                                                    |
| <b>Possible production by 2030</b> | Yes                                                                                                                                                                                                                     |

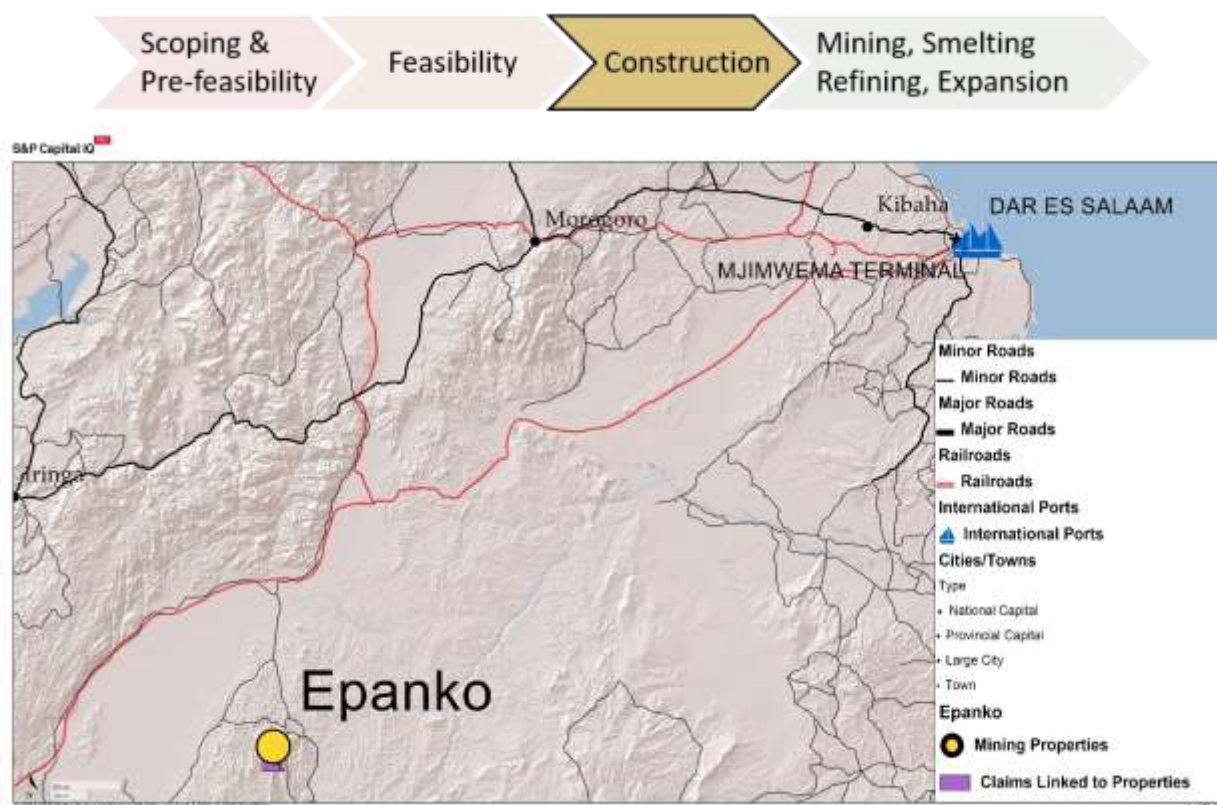


Figure 23. Epanko project location, Tanzania

#### 4.4.2 Economic assessment

##### General project background:

The Epanko project area was first recognised for graphite potential in 1914. EcoGraf (formerly Kibaran Resources) owns the project. The graphite mineralisation is hosted in a quartz-feldspar graphitic schist that is part of a Neoproterozoic metasedimentary package comprising marble and gneissic units. The graphite schist is subdivided from top to bottom into an oxide, transitional and fresh rock layer due to the weathering profile. Total graphitic carbon is assumed to be likewise continuous with the host rock unit. Metallurgical characteristics, principally flake size, has been observed to be of a consistent nature when observed in outcrops, trench exposure and diamond drill core at numerous locations within the licence area. Two zones of graphitic schist have been mapped, named Epanko East and Epanko West. The graphitic schist is open along strike and down dip in Epanko West. The Epanko East deposit is interpreted to be a recumbent fold, open along strike to the north and south. A sub-vertical shear zone offsets the stratigraphy down dip along the lower fold limb. The Epanko West Mineral Resource estimate is ~2,150 m in strike and in average 200 m thick. The company plans to mine and process oxide ore only for at least the first 11 years, which will postpone the construction of a sulphide circuit and the specially lined tailings cell intended for processing the fresh ore. Front End Engineering Design is underway. The company seeks investment for the construction of the infrastructure, the mine and the processing plant and is mandated for a loan of up to US\$ 105m from KfW IPEX-Bank.

##### Project description:

|                                     |                                                                                                                                                                                                                                                  |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                    | Flake graphite                                                                                                                                                                                                                                   |
| JORC compliant reserves             | 11.7 Mt @ 8.3 % TGC (2017) with updated reserve due 06/2024                                                                                                                                                                                      |
| Share of global graphite reserves   | 0.3 % ( <i>USGS estimate global graphite reserves of 320 Mt</i> )                                                                                                                                                                                |
| JORC compliant resources            | 290.8 Mt @ 7.2 % TGC                                                                                                                                                                                                                             |
| Share of global graphite resources  | 2.6 % ( <i>USGS estimate global graphite resources of 800 Mt</i> )                                                                                                                                                                               |
| Waste to ore ratio (whole orebody)  | 0.27                                                                                                                                                                                                                                             |
| Annual production                   | Stage 1: 73 kt of graphite concentrate, 300 kt envisaged                                                                                                                                                                                         |
| Life of mine                        | Stage 1: 18 years, >40 years total                                                                                                                                                                                                               |
| Investment required                 | Stage 1: US\$ 134m (for start of production)                                                                                                                                                                                                     |
| Net present value (NPV)             | Stage 1: US\$ 348m (10 % discount rate)                                                                                                                                                                                                          |
| Share of global graphite production | 7.1 % (for 73 kt/a) - 29.1 (for 300 kt/a) (recovery 94 %) ( <i>USGS estimate global graphite production of 1 Mt</i> )                                                                                                                            |
| Value addition potential            | EcoGraf has completed an initial assessment of the potential for locating mechanical shaping (micronising and spheronising) activities in Tanzania to produce battery graphite feedstock using cheaper low carbon footprint power from the grid. |

##### Mining and processing:

- Conventional open pit mining from the Epanko East and Epanko West deposits will employ (mostly) free dig mining of oxide ore and drill and blast of sulphide ore. The waste to ore

ratio was stated at 0.27 for Stage 1. It should be noted, however, that as mining progresses, greater depths are reached and the ratio increases.

- Processing of oxide ore requires minimal crushing/primary milling and uses less reagents compared to fresh ore. Milled oxide ore is screened and classified into the final product sizes (<150, >150, >180, >300 µm) bagged separately for transport to customers. Processing of sulphide ore will comprise additional crushing and grinding, sulphide flotation, milling and cleaner flotation. Plant feed is envisaged at 850 kt/a of ore (8.3 % TGC). Flotation testwork shows recoveries of 94 % producing a 96-98 % TGC concentrate. Epanko's product profile is for 65 % >150 µm and 35 % <150 µm flakes. C1 FOB production costs are US\$ 508/t graphite.
- EcoGraf is aiming for vertical integration. The company has developed a purification technology (EcoGraf HFfree™) to upgrade the flake graphite and produce high-performance battery anode material (99.95 % C). A product qualification plant is currently being commissioned in Australia and is scheduled to go into operation in 04/2024. The EcoGraf HFfree™ technology will also be utilised to recover and reuse anode materials (with an initial focus on production scrap from anode cell and battery manufacturing).

#### **BGR assessment and comments:**

- The deposit is a high-grade, high-tonnage and large flake-size graphite project with a low waste to ore ratio of 0.27. The long life of mine (>40 years) can be positive for regional development. The actual mine plan and resource estimate applies a cut-off grade of 5.5 %. EcoGraf has applied for a Special Mining License, which additionally includes a high potential area extending to the south.
- Economics do not include sales into the high-growth lithium-ion battery markets or value-added products from the proposed downstream processing facility, which yield significant potential for higher profitability.
- EcoGraf has signed binding offtake agreements with German groups Thyssen Krupp and Technogرافit for the production of high-grade graphite. Another agreement with POSCO considers the sale and purchase of EcoGraf's battery anode material for an initial term of 10 years (year 1: 7,500-12,500 t, years 2-5: 12,500-20,000 t/a and years 6-10: 20,000-40,000 t/a).
- Epanko is located ~480 km southwest of the capital Dar es Salaam. Product transport is possible via road ~70 km to Ifakara, and then by rail ~350 km to the port of Dar es Salaam for export. The nearest town, Mahenge (population 8,000) is ~5 km to the northeast. The company has entered into a Memorandum of Understanding with Tanzanian state electricity utility TANESCO under which the parties will coordinate and manage the construction of a 33 kV connection (10 km) to the TANESCO grid. Water is expected to be supplied by surface water (nearby streams) as well as groundwater (bore field).

### 4.4.3 ESG assessment

No severe ESG issues, which would pose a risk that could not be handled by diligent management and operational practice were identified at this stage. The level of publicly available information is adequate. KfW IPEX-bank confirmed eligibility for an Untied Loan Guarantee (UFG) up to US\$ 105m, based on a due diligence assessment against IFC Performance Standards by SRK Consultancy. EcoGraf states to be the first critical minerals development in Tanzania to complete a bankable feasibility study that satisfied the Equator Principles for environmental and social planning.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Environmental management                                           | ESIA independently assessed in 2017; recent biodiversity study confirmed the previous studies. No reports on any incidents found.                                                                                                                                                                                                                                                                                                                                                                                         |
| Efficient use of energy, renewable energy, GHG emissions reporting | Power supply during construction and production ramp-up from on-site diesel generators; connection to national grid (~40 % hydro share expected to increase as the Julius Nyerere dam ramps up) planned for production. Maximum installed power 2.8 MW, maximum demand approximately 2.4 MW stated in 2017 BFS. Decision to undertake additional energy-intensive processing step (mechanical shaping) in Tanzania instead of overseas will reduce related CO <sub>2</sub> emissions by 20 % and operating costs by 50 %. |
| Water management and consumption                                   | Semi-arid region with low water stress, but heavy seasonal rainfall and very high riverine flood risk. Water supply from pit dewatering and additional groundwater boreholes. No specific information on water demand available. A strategy for both subsurface, surface water and decant water management had been prepared for the BFS.                                                                                                                                                                                 |
| Pollution prevention                                               | EcoGraf notes some AMD potential of the sulfide orebody.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Air quality                                                        | Conventional drilling and blasting and tailings disposal operations will require dust suppression measures considering the low distance to settlements. Road transport of the concentrate in bulk bags.                                                                                                                                                                                                                                                                                                                   |
| Tailings management                                                | TSF planned as valley fill design; 660 kt/a over 18 years; guarantee the prevention of AMD by adequate measures is recommended.                                                                                                                                                                                                                                                                                                                                                                                           |
| Waste management                                                   | EcoGraf aims zero waste product development by value-add all by-products produced graphite processing and recycling of process water and reagents; no specific information reported.                                                                                                                                                                                                                                                                                                                                      |
| Hazardous materials management                                     | Flotation technology may imply use of hazardous reagents (in case of graphite flotation usually fuel oil or kerosene). Use of these reagents is considered low risk if handled responsibly.                                                                                                                                                                                                                                                                                                                               |
| Noise and vibration                                                | Conventional drilling and blasting mining; considering the distance to the next settlements basic impact mitigation measures (e.g. low-impact sequential blasting) appear sufficient.                                                                                                                                                                                                                                                                                                                                     |
| Protected areas and biodiversity                                   | Several small forest reserves and key biodiversity areas (predominately vulnerable plant species) located in the region. No information on distinct project impact available.                                                                                                                                                                                                                                                                                                                                             |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mine closure                                              | No information on rehabilitation approach available; financial provision for rehabilitation calculated at US\$ 8/t sold concentrate in 2017 BFS. Potential risk (and associated costs) of AMD might need special attention related post-closure monitoring and management.                                                                                                                                                                                                                                      |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Community health, safety and security                     | Project area sparsely populated and dominated by subsistence agriculture, forestry and artisanal mining are minor income sources. Mahenge township is the nearest major settlement (population of the Mahenge district around 10,000) about 5 km northeast from the project area; in case of Mahenge the distance appears large enough that the potential negative impact on the local population is generally considered low risk. Resettlement of people in smaller settlements in the project area required. |
| Dialogue and engagement with communities and stakeholders | No specific information on practice at Epanko available, but EcoGraf states extensive engagement local communities and Government officials in course of a Resettlement Action Plan update and refers to good practice and experience in community relations from a previous project.                                                                                                                                                                                                                           |
| Land acquisition and involuntary resettlement             | A handful of hamlets are impacted from resettlement actions; EcoGraf states good advancement in preparation of a Resettlement Action plan update; including land parcel delineation, preliminary asset valuation and socio-economic surveys. The finished plan will include a community investment packed consisting of e.g. housing, infrastructure, and community service facilities.                                                                                                                         |
| Occupational health & safety management                   | No specific information on OHS management available.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Workers' rights                                           | Tanzania scores 74/100 in the Labour Rights Index. Reports of traditional ASM in the region (gemstones and marble), no information on engagement available, but also no indication of deficiencies/conflicts found.                                                                                                                                                                                                                                                                                             |
| Gender and diversity                                      | Diversity policy in place, no specific quotas set. EcoGraf is of PreIWD, a non-profit organization to support women in mining and business, capacity building for women in corporate leadership.                                                                                                                                                                                                                                                                                                                |
| Local value added and community development               | EcoGraf plans permanent staff of 300 employees (95 % Tanzanian) and estimated 4,500 additional indirect jobs created. Mineral royalty 3.3 %. Forecasting of US\$ 3bn economic benefit to Tanzania for the first 40 years of operation. An update of the CSR plan was submitted to authorities as per new Mining Regulations in 2023.                                                                                                                                                                            |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Legal compliance                                          | Mining licence and environmental approval granted, with life-of-mine Special Mining Licence to be granted shortly. Epanko's social and environmental planning programs were independently assessed in 2017 by KfW IPEX-Bank appointed SRK (UK) to comply with the Equator Principles. No indication of any breaches of law found.                                                                                                                                                                               |
| Management practices                                      | Corporate Governance Plan based on the ASX Corporate Governance Council Recommendations in place.                                                                                                                                                                                                                                                                                                                                                                                                               |



| ESG category               | Assessment                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Transparency and reporting | Listed on ASX and FSE; traded at OTCQX; information on financial accounts and shareholder structure available. Adopted reporting frameworks: Equator Principles; IFC Performance Standards; World Bank Group Environmental Health and Safety Guidelines. Eligible for Untied Loan Guarantee (UFK) from German Government development bank KfW IPEX-Bank that implies evaluation against IFC Performance Standards. |
| Business ethics            | Tanzania scores 40/100 in the corruption perception index; Tanzania is an EITI country. Whistleblower policy, anti-bribery and anti-corruption policies in place. No indication of unethical practices by EcoGraf found.                                                                                                                                                                                           |

Table 33. ESG features of Epanko project, Tanzania

#### 4.4.4 Further reading

EcoGraf Ltd. (2023a): 38% Increase in Epanko Mineral Resource.

<https://www.ecograf.com.au/wp-content/uploads/2023/03/ASX-EGR-38-Increase-in-Epanko-Mineral-Resource-Final2.pdf> (accessed: 24.01.2024)

EcoGraf Ltd. (2023b): Epanko pre-development program delivers outstanding results.

<https://www.ecograf.com.au/wp-content/uploads/2023/04/2545203.pdf> (accessed: 24.01.2024)

EcoGraf Ltd. (2023c): KfW IPEX-Bank Mandated for UFK Loan of up to US\$105m (A\$160m) for Development of Epanko.

<https://www.ecograf.com.au/wp-content/uploads/2023/11/2649482.pdf> (accessed: 24.01.2024)

EcoGraf Ltd. (2023d): Annual. <https://www.ecograf.com.au/wp-content/uploads/2023/09/EcoGraf-Annual-Report-2023.pdf>

(accessed: 24.01.2024)

EcoGraf Ltd. (2023e): Annual General Meeting - Investor Presentation – 27

November 2023. <https://www.ecograf.com.au/wp-content/uploads/2023/11/2647973.pdf> (accessed: 24.01.2024)

EcoGraf Ltd. (2024): Quarterly Activities Report. <https://www.ecograf.com.au/wp-content/uploads/2024/01/2675077.pdf>

(23.04.2024)



## 4.5 Farim sedimentary phosphate project (Guinea-Bissau)

Information as of 03/2024

### 4.5.1 General project background

|                                    |                                                                                                                                                                               |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodities</b>         | Phosphate rock (Ph)                                                                                                                                                           |
| <b>Location</b>                    | Region Oio, Northern-Central Guinea-Bissau<br>12°29' N, 15°16' W, 20 - 40 m.a.s.l.                                                                                            |
| <b>License type</b>                | Mining Lease 004/2009 and 001/2009 (until 2034).<br>Currently requesting a renewal for 25 years from the date of the new issue.                                               |
| <b>License owner / operator</b>    | 100 % GB Minerals (100 % subsidiary of Itafos Inc.; public company)                                                                                                           |
| <b>Contact</b>                     | 5151 San Felipe Street, Suite 2015<br>Houston, TX 77056, USA<br><a href="https://itafos.com/">https://itafos.com/</a><br><a href="mailto:info@itafos.com">info@itafos.com</a> |
| <b>Project status</b>              | Feasibility                                                                                                                                                                   |
| <b>Possible production by 2030</b> | Yes                                                                                                                                                                           |



Figure 24. Farim project location, Guinea-Bissau

## 4.5.2 Economic assessment

### General project background:

The Farim phosphate deposit is located within a Middle Eocene Formation that forms part of the southern margin of the Mauritania-Senegal-Guinea Cenozoic sedimentary basin (Prian, 1987). The basin extends from Morocco (including the huge Phosphate deposits in Morocco) in the north through Mauritania, Senegal, Guinea-Bissau and into Guinea to the south. The phosphate bearing Mid-Eocene formations of the basin contain known phosphate horizons and host a number of important economic phosphate deposits, including Bofal in Mauritania and Taïba, Thiès and Matam in Senegal. It accounts for almost 25 % of the world's current rock phosphate production. The Farim phosphate deposit is a flat-lying sedimentary phosphatic bed, which underlies an area greater than 60 km<sup>2</sup>. The company announced a feasibility study in 06/2023. The overall scheduled duration from the start of detailed engineering to the end of commissioning is 31 months. The ramp-up period will commence in month 32, and the date of first commercial production is expected to be achieved within 6 months following commissioning. The company seeks investment for mine construction and infrastructure.

### Project description:

|                                    |                                                                                                         |
|------------------------------------|---------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Sedimentary Phosphate rock                                                                              |
| NI 43-101 reserves                 | 43.75 Mt @ 30.00 % Ph                                                                                   |
| Share of global Ph reserves        | 0.02 % ( <i>USGS estimate global Ph reserves of 74 Bnt</i> )                                            |
| NI 43-101 resource                 | 89.9 Mt @ 27.85 % Ph                                                                                    |
| Share of global Ph resources       | 0.01 % ( <i>USGS estimate global Ph resources of 300 Bnt</i> )                                          |
| Waste to ore ratio (whole orebody) | 11.3 m <sup>3</sup> /t of ore                                                                           |
| Annual production                  | 1.75 Mt (dry phosphate rock matrix @32.7 % P <sub>2</sub> O <sub>5</sub> )                              |
| Life of mine                       | 25 years                                                                                                |
| Investment required                | US\$ 308.27m (for start of production)                                                                  |
| Net present value (NPV)            | US\$ 572m (10 % discount rate, after tax with 3 years tax holiday)                                      |
| Share of global Ph production      | 0.9 % ( <i>USGS estimate global Ph production of 64 Mt P<sub>2</sub>O<sub>5</sub> in 2023</i> )         |
| Value addition potential           | Phosphate fertilizer production. Which would require the import and/or on site production of chemicals. |

### Mining and processing:

- Conventional open pit mining without blasting. Free dig is planned with relatively small excavators (with 5 m<sup>3</sup> buckets and 36 t trucks, in order to allow a selective mining)
- Processing only includes the removal of impurities from the ore feed to increase the P<sub>2</sub>O<sub>5</sub> content. This done by rejecting material of a size <20 µm and >1,180 µm using drum and attrition scrubbing stages, cyclones, vibrating screens, and hydro separators.
- The product is then filtered and dried for shipping

**BGR assessment and comments:**

- The deposit is a low to medium tonnage and a medium to high-grade operation with a relatively high waste to ore ratio of  $\sim 11.3 \text{ m}^3/\text{t}$  of ore.
- The ore zone has a thickness of only 1.5 to 6.25 m. A variation to a thinner zone would highly influence the waste to ore ratio and thus project economics. The tailings will only consist of material  $< 20 \text{ }\mu\text{m}$ , which is very small and request a high stability of the dam due to the expected difficulties in dewatering the material.
- The Technical Report states that dewatering the pit and prevention of pit inflow from a nearby river is most critical to mining. Which could lead to a reduced temporary slope angle and possibly to an interruption of mining during the rainy season. The non-permanent slope angle of  $65^\circ$  during mining is considered possibly critical especially during the rainy season.
- The project economics given in the Technical Report point to a very high IRR of 34.9 and a payback time of 4.2 and thus a robust feasibility. The assumed selling price is reflecting the actual phosphate rock price for concentrates of 68 % BPL (bone phosphate of lime; 2.185 times  $\text{P}_2\text{O}_5$  grade) and the Farim concentrate will have a grade of almost 72 % according to the Feasibility Study. Therefore, they would be traded with a premium, which is also stated in the Feasibility Study. Contract mining is planned for the operation and the costs were calculated forward to 2022 based on a quotation from 2019. As prices have surged from 2022 to 2024 this would negatively influence the economics. This is the same for production equipment.

**4.5.3 ESG assessment**

The NI 43-101 Technical Report (2023) on the company website is a major basis for this ESG assessment. Information on some ESG management issues is limited given the early stage of the project but the company ESG report 2023 of Itafos provides some information also for Farim. Water management is seen as a critical issue given the riverine location and flood risk as well as a high seasonal precipitation. The issue of worker's rights as well as of ensuring protective measures in closure and post-closure are also relevant given pollution risk related to acid mine drainage and radioactive elements.

| ESG category             | Assessment                                                                                                                                                                                                                                                                   |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>       |                                                                                                                                                                                                                                                                              |
| Environmental management | ESIA based on International Finance Corporation guidelines and Equator principles. Environmental baseline studies were conducted (2011-2015; 2016-2019) and respective management plans developed. Training and an environmental monitoring has been established since 2016. |

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Efficient use of energy, renewable energy, GHG emissions reporting | Remote location, limited power supply precludes the use of electric mining equipment. Power for the project will be supplied from an onsite hybrid power plant with solar and diesel power, it is assumed that 36% of power generation will be supplied by solar power over the life-of-mine. An installed capacity of about 10 MW is envisaged for the plant and the port facilities.                                                                                                                                                                                                                                                                                                          |
| Water management and consumption                                   | The project is located in an area of low water stress, but with high riverine flood risk; rainy season from June to October (1,400 mm/a); Water management at the site is highly relevant. An environmental management plan was advanced for water and monitoring established. A status report on monitoring was prepared 2021. Risk of Flooding e.g. due to river rise, requires protection measures e.g. bunds, water ponds. A groundwater model had been developed. Dewatering of groundwater to pit level is needed, which is stated to impact a significant number of water users. The process water need is 2,200 m <sup>3</sup> /a sourced from a mostly closed circulating loop system. |
| Pollution prevention                                               | Overburden is potentially acid generating only in some parts. The tailings contain high levels of element enrichment with antimony, bismuth, phosphorous, selenium and uranium as well as elevated lead-210 and radium-226, however it is stated that neutral pH does not allow for isotope leaching (technical report 2023); sediment control dams and environmental control dams are planned to prevent spills.                                                                                                                                                                                                                                                                               |
| Air quality                                                        | Exposure to Radium-226; mitigation measures such as open walled structures can limit exposure.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Tailings management                                                | Elevated metal concentrations in overburden and tailings (antimony, bismuth, phosphorous, selenium and uranium) and partial acid generating potential and mobilization of nickel and cadmium requires adequate containment to prevent seepage to groundwater and discharge to surface water. Also, some radioactivity needs respective measures. Processing waste was calculated to around 345,000 t tailings for a 20 year period.                                                                                                                                                                                                                                                             |
| Waste management                                                   | Three types of overburden storage facilities planned, a substantial amount of overburden material was used for construction of the flood protection bund and the embankment walls for the tailings storage facility. Processing waste was calculated to around 85000 oversize waste for a 20 year period.                                                                                                                                                                                                                                                                                                                                                                                       |
| Hazardous materials management                                     | Processing of phosphates includes the use of sulphuric acids and of other chemicals in the flotation process requiring safe handling.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Noise and vibration                                                | Scarcely populated region. General risk rated low.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Protected areas and biodiversity                                   | The project is not located in a key biodiversity area (KBA) and no protected areas are located near the project site. The Rio Cacheu Mangroves Natural Park (KBA) is located approximately 70 km downstream of the site, which borders the Cacheu river. Baseline terrestrial and aquatic biodiversity studies were conducted and a biodiversity management plan was developed 2015, an update is recommended.                                                                                                                                                                                                                                                                                  |
| Mine closure                                                       | Local population should be shielded from long-term radioactive exposure by suitable mitigation measures (e.g. sufficient cover on TSF, no placing of acid generating material in TSF as recommended in the technical report). A                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | preliminary Mine Reclamation and Closure Plan and closure cost estimate has been prepared.                                                                                                                                                                                                                                                                                                                                                         |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Community health, safety and security                     | The local economy is based on agriculture, cashew nuts, and fishing. The area is sparsely populated with Farim being the largest town in the vicinity (7,000 people). Social baseline assessment was conducted 2015; the technical report 2023 recommends an update as well as an updated land and asset survey for resettlement planning, water use is from wells, there is no local power supply.                                                |
| Dialogue and engagement with communities and stakeholders | Consultations have been conducted during the baseline assessment. Ongoing community engagement was recommended to be continued through the normal care and maintenance activities currently happening on site.                                                                                                                                                                                                                                     |
| Land acquisition and involuntary resettlement             | A Resettlement Action Plan was prepared for the project in 2018, including a resettlement village north of the site. No number of affected people is reported, but five villages are affected. Itafos reported investment of US\$ 900.000 in resettlement (2021).                                                                                                                                                                                  |
| Occupational health & safety management                   | The company ESG report states that it has a TRIFR (Total Recordable Injury Frequency Rate) of 0.57, which is below the average of the sector. There has been no incident at Farim since 2019 (however only 39 employees at that stage). Exposure to Radium-226; mitigation measures such as open walled structures can limit exposure. The company has devised a program of free health checks for all staff and has taken related health measures |
| Workers' rights                                           | Guinea-Bissau is not rated in the Labour Rights Index. In May 2023 the International Trade Union Confederation were forced to close down offices, threats against trade unionists reported. No information on company website available.                                                                                                                                                                                                           |
| Gender and diversity                                      | Diversity, inclusion and equity policy is available on company website. No specific information available.                                                                                                                                                                                                                                                                                                                                         |
| Local value added and community development               | Sourcing and training of local personnel planned, however part of the labour force will need to be sourced from expatriate personnel from neighbouring countries. Itafos reports on community outreach programs dedicated to health, education and culture (e.g. renovation of sports facility, a Covid-19 pandemic program, and hygiene training for all schools in Farim).                                                                       |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Legal compliance                                          | Environmental license expired 2019, process of renewal was interrupted during pandemic, the owner seeks the renewal of the Declaration of Environmental Compliance from the Competent Environmental Assessment Authority                                                                                                                                                                                                                           |
| Management practices                                      | No information on management practices on company website available.                                                                                                                                                                                                                                                                                                                                                                               |
| Transparency and reporting                                | Itafos is listed on the Canadian TSXV. Investors and financial information (stock exchange listing) on website.                                                                                                                                                                                                                                                                                                                                    |

| ESG category    | Assessment                                                                                                                                                                                                                                                                                                                    |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Business ethics | Guinea-Bissau is not an EITI implementing country and scores 22/100 in the Corruption Perception Index. As stock exchange listed company Itafos has relevant ethic policies and Code of Conduct available on its website. No indication of unethical company practices found; anti-bribery and whistleblower policy in place. |

Table 34. ESG features of Farim project, Guinea-Bissau

#### 4.5.4 Further reading

Ausenco Engineering Canada Inc. (2023): Farim Phosphate Project NI 43-101 Technical Report and Feasibility Study, Guinea-Bissau, West Africa, <https://itafos.com/site/assets/files/1898/farim-ni-43-101-report-final-jun26.pdf> (accessed 05.04.2024)

Itafos (2023): Environmental, Social and Governance Report 2023, <https://itafos.com/site/assets/files/2218/2023-itafos-esg-report.pdf> (accessed 19.04.2024)

Mining Technology (2023): Farim Phosphate Project, West Africa; <https://www.mining-technology.com/projects/farim-phosphate-project-west-africa/?cf-view> (accessed 05.04.2024)



## 4.6 Graphmada flake graphite project (Madagascar)

Information as of 01/2024

### 4.6.1 General project background

|                                    |                                                                                                                                                                                                                                          |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Graphite                                                                                                                                                                                                                                 |
| <b>Location</b>                    | Toamasina, Madagascar<br>18°56' S, 48°60' E, 0 – 400 m.a.s.l.                                                                                                                                                                            |
| <b>License type</b>                | Mining permits: PE 25600 and PE 26670 (40 years granted) and Loharano pending renewal (~20 km <sup>2</sup> )                                                                                                                             |
| <b>License owner / operator</b>    | Greenwing Resources Ltd. (public company)                                                                                                                                                                                                |
| <b>Contact</b>                     | Matisse Tower, Level 21, 110 Mary Street                                                                                                                                                                                                 |
| Direct contact established: No     | Brisbane, Queensland 4000<br><a href="https://greenwingresources.com/our-projects/graphmada/">https://greenwingresources.com/our-projects/graphmada/</a><br><a href="mailto:info@greenwingresources.com">info@greenwingresources.com</a> |
| <b>Project status</b>              | Expansion; currently on care and maintenance                                                                                                                                                                                             |
| <b>Possible production by 2030</b> | Yes                                                                                                                                                                                                                                      |

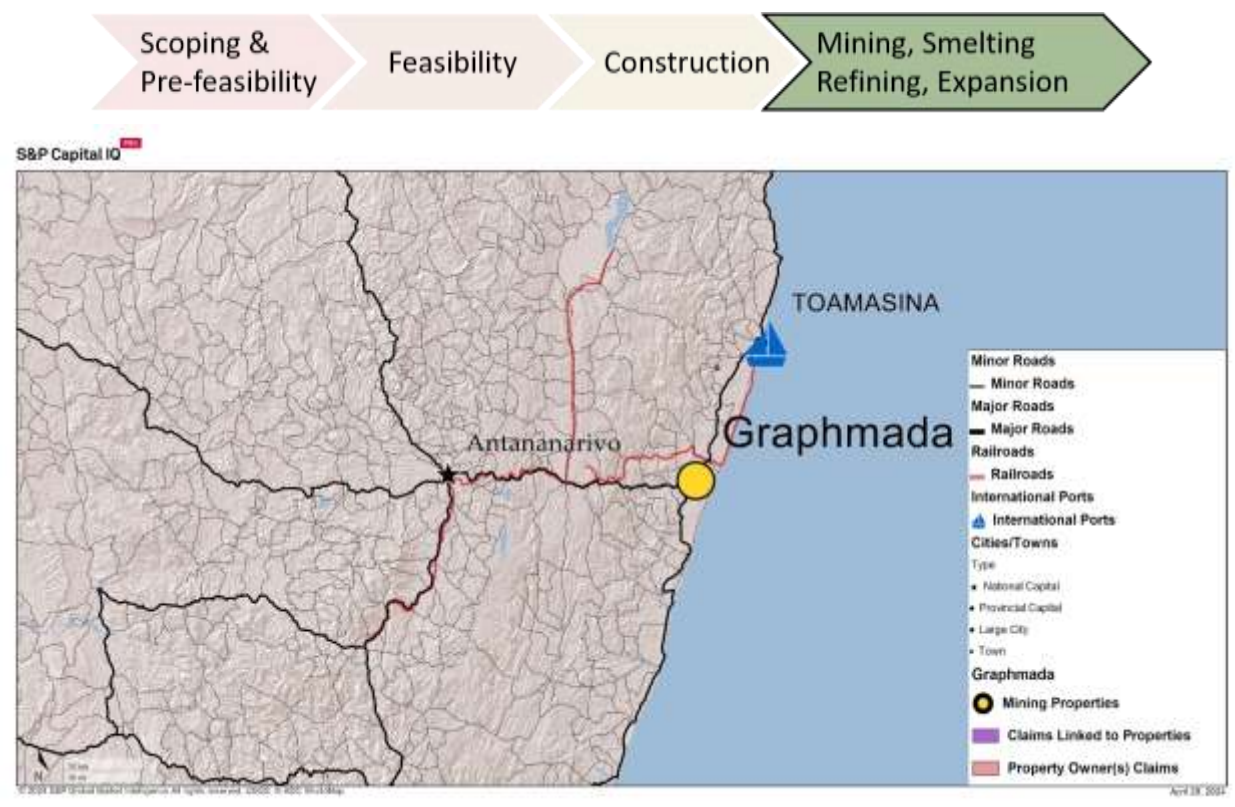


Figure 25. Graphmada project location, Madagascar



## 4.6.2 Economic assessment

### General project background:

The Graphmada graphite potential was discovered in the 1950s by the French geological survey BRGM und has been systematically explored since 2013. Greenwing Resources Ltd. (formerly Bass Metals Ltd.) acquired the Graphmada assets from StratMin Global in 2016. There was Graphite production in 2019 and 2020 at Graphmada, but in 2020, the mine was placed into care and maintenance due to the impacts of COVID-19 and additional control measures issued by the government. At Graphmada, the graphite mineralisation is extensive, both laterally and in thickness of the ore body. Two different types of graphite mineralisation include the shallow, regolith-hosted and underlying gneiss-hosted natural flake graphite. The gneiss-hosted graphite occurs in graphitic gneisses within Neoproterozoic metasedimentary rocks. Weathering of the graphitic gneiss concentrated the graphite in the regolith. The mineralisation strikes north-south and is open ended to both directions. Four mineralised zones, namely Loharano (~0.2 km<sup>2</sup>), Mahela (~0.7 km<sup>2</sup>), Mahefedok (~0.2 km<sup>2</sup>) and Ambatofafana (~0.4 km<sup>2</sup>) were included in the resource estimate, which resulted 62 Mt @ 4.5 % TGC. The owner seeks investment for the completion of feasibility studies, addressing the expansion of Graphmada and the recovery of gneiss-hosted graphite.

### Project description:

|                                                      |                                                                                                                                    |
|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                                     | Flake graphite                                                                                                                     |
| JORC compliant resources                             | 62 Mt @ 4.5 % TGC                                                                                                                  |
| Share of global graphite resources                   | 0.35 % ( <i>USGS estimate global graphite resources of 800 Mt</i> )                                                                |
| Waste to ore ratio (whole orebody)                   | Expected to be relatively low due to near-surface mining                                                                           |
| Annual production                                    | 2019: 4,031 t of flake graphite; 2020: 1,836 t of flake graphite<br>Planned: 40,000 t of flake graphite                            |
| Life of mine                                         | Up to 20 years                                                                                                                     |
| Investment required                                  | CAPEX for feasibility study on project expansion not available                                                                     |
| Net present value (NPV)                              | Not published                                                                                                                      |
| Share of global graphite production (post-expansion) | 4.0 % (40 kt of flake graphite, recovery 83-96 %)<br>( <i>USGS estimate global graphite production of 1 Mt</i> )                   |
| Value addition potential                             | The company signed a MoU with Urbix to establish a joint facility in Madagascar to produce a purified high value graphite product. |

### Mining and processing:

- The deposit will be mined via the truck and shovel ('free dig') mining method which is economic to exploit to the depths currently modelled. So far, there are no assumptions regarding minimum mining widths and dilution.
- Flotation tests confirmed that a range of concentrates with overall grades between ~83 and 96 % TGC, with 60-70 % of the flakes larger than 180 µm could be produced depending on

process parameters. Recoveries ranged between 75 and 92 %. Graphite recovered from Graphmada's regolith-hosted mineralisation is favourable for a wide use in various carbon applications and market segments, including the lithium battery anode market. Recently completed tests with Urbix showed graphite could be purified to above 99.9 % for the >180-micron flakes, and 99.7 % for >300-microns.

- The company notes increases in graphite concentrate prices over recent times, with the price of the <100 mesh 94-95% TGC contract achieving prices of US\$ 620/t on a free on-board basis. This compares to a price of ~US\$ 330/t FOB received by the company for this concentrate specification in the last quarter of 2019 prior to placing the mine on care and maintenance.

#### **BGR assessment and comments:**

- The deposit is a medium-grade, high-tonnage and large flake-size graphite project. The relatively shallow position of the mineralisation should allow for low waste mining. The relatively long life of mine (>20 years) can be positive for the development of the region. The actual mine plan and resource estimate does not include TGC grades below 3 %, which yields significant resource upgrade potential and probable extension of the mine life.
- With the expansion of the Graphmada plant, Greenwing aims to reduce operating costs. Until the project was placed on care and maintenance, the energy costs incurred by the diesel generators accounted for 47 % of operating costs. As part of Madagascar's electrification programme, Graphmada could be connected to the hydropower grid in the near future, which could reduce operating costs by 30 %. The company plans to mine and process the hard rock graphite. It should be noted that the operating costs will increase in the course of the project due to higher mining costs (greater depths, blasting) and higher power consumption during processing.
- So far, the mine has sold a range of graphite concentrates to customers in Europe under an off-take agreement and on order to customers in India, China, and the United States. In March 2021, the company had been accepted into the European Battery Alliance planning to produce significant graphite and advanced material products for the European market. As part of the acquisition agreement with Stratmin, Greenwing has to pay a 2.5 % sales royalty terminating in 2029 or upon total royalty payments reaching US\$ 5m, whichever occurs first.
- The Graphmada Mining Complex is located near the town of Brickaville on the east coast of Madagascar, 236 km by road east of the capital Antananarivo and 100 km south of the port of Toamasina. The mine site is accessed from the main highway to Antananarivo via a 2 km haul road. As part of Madagascar's electrification programme, Graphmada could be connected to the hydropower grid in the short to medium term, which could reduce operating costs by 30 %.

### 4.6.3 ESG assessment

Although the project was already in production until 2019, no EIA or detailed information on various management and ESG aspects is available. The Company stated that test results on certain ESG aspects and a mine closure plan will be available as part of the ongoing feasibility studies for the expansion of the project. To date, no ESG issues have been identified that preclude responsible investment, results of ongoing assessments would be needed.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                      |
| Environmental management                                           | No reports on incidents found. No information on environmental management issues available on company website.                                                                                                                                                                                                       |
| Efficient use of energy, renewable energy, GHG emissions reporting | Until 2020, the power demand was covered by diesel generators. As part of Madagascar's electrification programme, Graphmada could be connected to the hydropower grid in the short to medium term. In 2020, 87 % of installed electricity generation was from renewables (bioenergy; IRENA 2022)                     |
| Water management and consumption                                   | Water stress in the area is considered to be low; precipitation 150 – 500 mm with a warmer and rainier period from December to April. The company does not provide information on water supply. Potential for riverine floods, tropical storms and heavy rainfall events, respective stormwater management required. |
| Pollution prevention                                               | The company predicts little to no AMD, however, will include results from testing AMD potential of ores and waste rock. Potential impacts from noise, dust, odour, surface water, groundwater pollution will be addressed in a feasibility study. Flotation technology may imply use of hazardous reagents.          |
| Air quality                                                        | The impact depends on the distance from the settlements (10 km to the village of Antsampanana), but the risks are estimated to be low with diligent operation. Dust from road transport might require respective mitigation measures.                                                                                |
| Tailings management                                                | An annual production of 40,000 t of graphite over a LOM period of 20 years requires a TSF of at least 18 Mt. No information on management standards available.                                                                                                                                                       |
| Waste management                                                   | Progressive backfill of mining waste and subsequent cover with topsoil envisaged.                                                                                                                                                                                                                                    |
| Hazardous materials management                                     | No relevant information available for review at this stage.                                                                                                                                                                                                                                                          |
| Noise and vibration                                                | The impact depends on the distance to the settlements after resettlement (10 km to the village of Antsampanana), although the risks are estimated to be low with diligent operation.                                                                                                                                 |
| Protected areas and biodiversity                                   | The mine site is not located in a protected or key biodiversity area. The Mangoro-Rianila Rivers Key Biodiversity Area is located around 5 km downstream of the river system close to the site.                                                                                                                      |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mine closure                                              | No detailed information on mine closure available for review at this stage. The company plans waste refilling and topsoil coverage.                                                                                                                                                                                                                                                       |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                           |
| Community health, safety and security                     | The mine site is located ~10 km north of Antsampanana and ~25 km south of Brickaville, which are both classified as dense and semi-dense urban clusters. The project area is sparsely settled. Agriculture extends right up to the mine site. Potential negative impacts from the mine on local communities are generally considered as low.                                              |
| Dialogue and engagement with communities and stakeholders | The company runs a CSR program called Graphmada Care. The program is based on the commitment by the company to develop its business through strong local partnerships built on education, health, production, transparency and empowerment and was recognised as the leading programme of its kind in Madagascar in 2018.                                                                 |
| Land acquisition and involuntary resettlement             | No detailed information on the company's resettlement policy available. The mine site is not close to any cultural heritage site. Anticipating a diligent resettlement process, negative impact on the local population is considered in general low risk.                                                                                                                                |
| Occupational health & safety management                   | No information on OHS management practice available. No records of health and safety incidents available. Project is located in dengue and malaria region.                                                                                                                                                                                                                                |
| Workers' rights                                           | Madagascar scores 65/100 in the Labour Rights Index. ASM activities in the area are not known. No information on specific workers' rights situation at the companies' operations available for review.                                                                                                                                                                                    |
| Gender and diversity                                      | The Company intends to consider the recommendations and guidance in the ASX Corporate Governance Council's Principles and Recommendations. However, the Diversity Policy is not part of an employee's contract of employment with the Company and does not give rise to any contractual obligations.                                                                                      |
| Local value added and community development               | There is no information on local value addition and community development available. Company tax rate is 20 % and a royalty of 2 % is applied to graphite sales. The implementation of the new mining code provides for an increase in the royalty to 5 % and the creation of an investment fund for social and communal mining based on a contribution of 3 % of the CAPEX of a project. |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                           |
| Legal compliance                                          | Mining permits for PE 25600 and PE 26670 are granted for 40 years and Loharano is pending renewal (~20 km <sup>2</sup> ). No indication of any violation of the law found.                                                                                                                                                                                                                |
| Management practices                                      | Corporate governance policies on company level available, but very limited information on management practices, evidence of practice on mine site is not yet available.                                                                                                                                                                                                                   |
| Transparency and reporting                                | Listed on ASX; information for investors, reports on financial accounts and shareholder structure available.                                                                                                                                                                                                                                                                              |

| ESG category    | Assessment                                                                                                                                                                                                                                               |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Business ethics | Greenwing has some general ethics policies (e.g. code of conduct) available online on its investors section, however no information on management practices. Madagascar scores 25/100 in the Corruption perception Index; Madagascar is an EITI country. |

Table 35. ESG features of the Graphmada project, Madagascar

#### 4.6.4 Further reading

Greenwing Resources Ltd. (2022): Mineral Resource Update: 212 % increase in graphite resource at Graphmada Mining Complex.

<https://wcsecure.weblink.com.au/pdf/GW1/02540997.pdf> (accessed: 12.01.2024)

Greenwing Resources Ltd. (2023): Annual Report for the year ended 30 June 2023.

<https://wcsecure.weblink.com.au/pdf/GW1/02718149.pdf> (accessed: 15.01.2024)

International Renewable Energy Agency IRENA (2022). Renewable Energy Statistics 2022.

[https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jul/IRENA\\_Renewable\\_energy\\_statistics\\_2022.pdf?rev=8e3c22a36f964fa2ad8a50e0b4437870](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jul/IRENA_Renewable_energy_statistics_2022.pdf?rev=8e3c22a36f964fa2ad8a50e0b4437870) (accessed: 15.01.2024)

## 4.7 K.Hill shale-hosted Mn project (Botswana)

Information as of 01/2024

### 4.7.1 General project background

|                                    |                                                                                                                                                                                                                                    |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Manganese ore / Manganese sulphate                                                                                                                                                                                                 |
| <b>Location</b>                    | Southern Province, Botswana<br>25°00' S, 25°18' E,                                                                                                                                                                                 |
| <b>License type</b>                | Prospecting licence no. PL322/2016 (1,960 km <sup>2</sup> ), mining licence submission to follow EIS                                                                                                                               |
| <b>License owner / operator</b>    | Giyani Metals Corp.                                                                                                                                                                                                                |
| <b>Contact</b>                     | Suite 1700, 666 Burrad Street<br>Vancouver, British Columbia V6C2X8, Canada<br><a href="https://giyanimetals.com/contact">https://giyanimetals.com/contact</a><br><a href="mailto:info@giyanimetals.com">info@giyanimetals.com</a> |
| <b>Project status</b>              | Feasibility study completed, Demonstration plant for HPMSM under construction                                                                                                                                                      |
| <b>Possible production by 2030</b> | Yes, announced for 2025                                                                                                                                                                                                            |

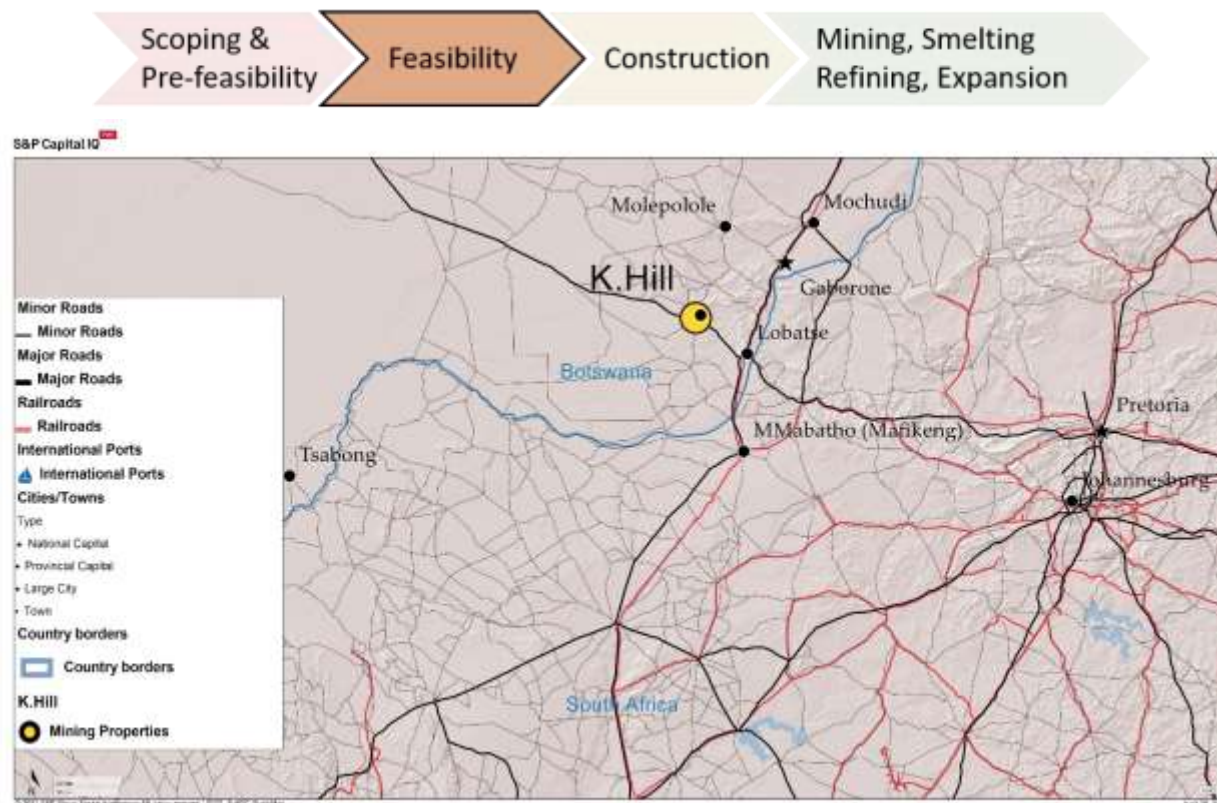


Figure 26. K.Hill project location, Botswana



## 4.7.2 Economic assessment

### General project background:

K.Hill project is a brownfield manganese oxide asset. Manganese was first mined in the late 50's. The main mineralisation is located in a 50 m thick Mn-shale unit, which is part of the Black Reef Quartzite Formation. The project is in feasibility stage with a planned start of production in 2026. The processing plant will treat 200 kt/a of RoM ore from the K.Hill Project open pit at an average grade of 18.9 % MnO to produce 80 kt/a high-purity manganese sulphate monohydrate (HPMSM), directly from the oxide ore. HPMSM is an essential part of current and future cathode material for lithium-ion batteries. The demonstration plant for the production of HPMSM will be built in Johannesburg, South Africa. After establishing a process for the production of HPMSM the commercial plant will be located in Botswana, close to the manganese deposit.

### Project description:

|                                         |                                                                                                                                       |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                        | Supergene-enriched Mn-shale                                                                                                           |
| NI 43-101 compliant probable reserves   | 2.03 Mt @ 18.9 % MnO (14.74 % Mn)                                                                                                     |
| Share of global Mn reserves             | 0.01 % ( <i>USGS estimate global Mn reserves of 1,700 Mt</i> )                                                                        |
| NI 43-101 compliant inferred resources  | 6.1 Mt @ 14.1 % MnO                                                                                                                   |
| NI 43-101 compliant indicated resources | 8.6 Mt @ 15.2 % MnO                                                                                                                   |
| Waste to ore ratio (whole orebody)      | 5.0 for 2.03 Mt                                                                                                                       |
| Annual production of HPMSM              | 80 kt HPMSM (200kt R=M)                                                                                                               |
| Life of mine                            | 57 years, however EIA is only valid for the initial 11 years LOM                                                                      |
| Investment required                     | US\$ 284m (CAPEX for construction of mine & processing plant)                                                                         |
| Net present value (NPV)                 | US\$ 984m (Post-tax 8 % discount rate); average HPMSM price (year 1-5): US\$ 3,373/t; average HPMSM price (from year 6): US\$ 3,918/t |
| Share of global HPMSM production        | 20 % based on a production of 128.000 t Mn contained of HPMSM production in 2022                                                      |
| Value addition potential                | Manganese ore will be processed to HPMSM                                                                                              |

### Mining and processing/refining:

- The K.Hill orebody will be extracted in an open pit using a conventional truck-and-shovel mining method. These mining activities are easily manageable with a relatively small fleet of hydraulic excavators and articulated dump trucks. Afterwards the material will be hauled either to the plant, the stockpile or the waste rock dump.
- The processing plant for the production of HPMSM will treat 200 kt/a of ROM material from the open pit at head grade of 15.2 % MnO. The process comprises crushing and grinding to reduce the ROM material to a characteristic grind (P80) of 150 µm, an acid reductive leach in sulphate media at an elevated temperature using sulphur dioxide as a reductant, followed by sequential precipitation and purification processes for the removal of metal impurities. Fluorite



polishing is undertaken to further improve the purity of the solution. The purified solution then undergoes evaporative crystallisation, followed by filtration and drying of the product, to produce an HPMSM final product.

- Metallurgical processing reagents and raw materials constitute the largest component of processing expenditure based on the plant design criteria and flowsheet to produce HPMSM.

#### **BGR assessment and comments:**

- The deposit is a low-grade operation with a waste to ore ratio of 5. The relatively long life of mine, first phase 11 years with expansion to 57 years can be positive for the development of the region.
- Due to its low manganese content, the project is of little economic importance for the general manganese market, but with the production of HPMSM, this project is able to fill an important gap in terms of future HPMSM demand. In addition, there is an increasing demand for HPMSM that is produced outside of China and K.Hill is one of only a few projects outside of China that is already in a feasibility stage.
- Giyani Metals Corps assumes an average realized HPMSM price for its economic assessment of US\$ 3,559/t for the years 1 to 5 and US\$ 3,780/t for year 6 onwards its economic assessment. The average price for HPMSM, produced mainly in China, from 2021-2023 was US\$ 1,092.5/t. HPMSM that is produced outside of China comes with much higher capital costs, ESG standards and a low carbon footprint production. This results in much higher costs compared to products from China.
- K.Hill is connected to five seaports, shipping to the US, EU and Asia (Walvis Bay, Beira, Maputo, Richards Bay and Durban) via rail and road, which is already in place. Project area is located close to one of the bigger cities in Botswana, Kanye. Water supply for mining operations is to be sourced from a combination of the existing WUC (Water Utilities Corporation) network and supplemented by groundwater extracted by Giyani via a new proposed wellfield.

#### **4.7.3 ESG assessment**

As the project is still at the feasibility and planning stage, detailed information on various ESG issues is not yet available (Environmental Impact Study under review at the Department of Environmental Affairs (DEA) as of Sep 2023.). No major ESG issues were identified so far that would preclude responsible investment. The operator comprehensively documents its corporate policies and management systems and is committed to comply with the IFC Performance Standards on Environmental and Social Responsibility. The K.Hill Project will cause environmental and social impacts, both negative (e.g., dust raised in working areas) and positive (e.g.,

employment opportunities and increased economic activity). The area of South-east Botswana qualifies as a Key Biodiversity Area. The mining site also is located in an arid area with low water use.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Environmental Management                                           | Comprehensive policies and reporting documented EMP was developed for EIA phase, monitoring plan to be developed. No incidents records found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Efficient use of energy, renewable energy, GHG emissions reporting | 4.5 MWdc solar farm will reduce the amount of energy taken from the national grid. Electric/Hydrogen mining fleet – where such vehicles will be available for operations. 3.2 kg CO <sub>2</sub> -eq. per kg HPMSM for Scope 1, 2 & 3 emissions (LCA study by Minviro).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Water management and consumption                                   | The mining site is located in an arid with low water use region. Water supply for mining operations is to be sourced from a combination of the existing WUC network and supplemented by groundwater extracted by Giyani via a new proposed wellfield. Water demand for the mining operations, estimated to be 50 m <sup>3</sup> /hour. Dewatering of the pit will be required in some parts that will be below groundwater level. It will be pumped to a pollutions control dam for use in the processing plant. Updating the mine water balance and ensuring storm water and water inflow management is recommended for feasibility stage. AMD potential from geology and leaching potential is not yet known, however geochemistry and acid mine test work is recommended for the feasibility stage. |
| Pollution prevention                                               | The solids removed during sequential purification and fluorite polishing will be disposed of in the TSF or stored as an intermediate product. All liquors removed in the treatment of the mineralised material will be treated for reuse or used for haul road dust suppression.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Air quality                                                        | Mining and processing/refining may be accompanied by gas and dust emissions which could have an impact on the community, as the city of Kanye with more than 50,000 inhabitants (2011) is located nearby. However, air and noise monitoring will be implemented to keep the risk for the community as low as possible. The processing plant area infrastructure will comprise a scrubber, to ensure that the gases released comply with emission standards, and plant utilities.                                                                                                                                                                                                                                                                                                                       |
| Tailings management                                                | Downstream tailings facility planned (total required capacity 16.2 Mm <sup>3</sup> ), dry stacking not considered because of high water content; classification according to the Global Dam failure consequence classification as of Industry Standard on Tailings Management (GTR 2021) as high;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Waste management                                                   | Waste from the processing plant will be classified as either hazardous or non-hazardous. Hazardous waste will need to be disposed of at a licenced hazardous waste facility, which will be identified during the final waste classification. Mining waste for the K.Hill Project will comprise waste rock and tailings, which will be disposed of in the designated TSF within the Project site.                                                                                                                                                                                                                                                                                                                                                                                                       |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hazardous materials management                            | Hazardous waste will need to be disposed of at a licenced hazardous waste facility, which will be identified during the final waste classification.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Noise and vibration                                       | Noise and vibration caused by mining can certainly have an impact on the surrounding communities, as the city of Kanye with more than 50,000 (2011) inhabitants is located nearby. However, air and noise monitoring will be implemented to keep the risk for the community as low as possible.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Protected areas and biodiversity                          | <p>The mine site is not located in a protected area, however, the area of South-east Botswana qualifies as a Key Biodiversity Area of international significance because it meets one or more previously established criteria and thresholds for identifying sites of biodiversity importance (including Important Bird and Biodiversity Areas, Alliance for Zero Extinction sites, and Key Biodiversity Areas).</p> <p>However, according to the PEA identified mammals in the designated mining area are classified as least concern on the International Union for Conservation of Nature red list and no protected or scarce trees, such as the Baobab, Marula, Mopane or Fig trees, have been observed.</p> |
| Mine closure                                              | TSF closure costs are calculated to US\$ 3.8m and the current EIA closure and general rehabilitation plan funding requirements comprise US\$ 4.6m. The closure cost is scheduled 12 months prior to the end of LOM. Closure plan to be developed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Community health, safety and security                     | Kanye has a population of around 50,000 (2011) inhabitants and is therefore one of the larger cities in Botswana. So the project area is relatively densely populated compared to other regions in Botswana. Potential negative impacts from the mine on local communities as noise, dust, etc. shall therefore be kept as low as possible.                                                                                                                                                                                                                                                                                                                                                                      |
| Dialogue and engagement with communities and stakeholders | Giyani's social engagement in Botswana includes support for the local community and participation in community engagements including Kgotla meetings called by the Members of Parliament of Kanye. Giyani states that they will continue to engage with a wide range of stakeholders.                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Land acquisition and involuntary resettlement             | It is a former mining site, however farmers, water reservoirs and the BOCRA Tower has to be relocated but in accordance with the community and approval of the farmers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Occupational health & safety management                   | The company is committed to develop and implement OHS monitoring and management plans and comply with all applicable laws and regulations as well as aim to achieve best practice in OHS that meet international standards.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Workers' rights                                           | Botswana scores 42/100 in the Labour Rights Index. Lowest indicator scores for Botswana: Maternity at work, Employment Security, Trade Union. To date, local people have been employed on short-term contracts to work on exploration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Gender and diversity                                      | Human rights policy, Diversity and Inclusion policy, Ethics policy in place.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Local value added and community development               | Local value contribution considered generally high. An employment policy to give priority to local people once the project is commissioned. Support of further education and training. Adopting a local procurement policy that                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

| ESG category               | Assessment                                                                                                                                                                                                                                                                                                                                           |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | prioritises the purchase of goods and services from local suppliers wherever possible. The implementation of community development plans to facilitate socio-economic development and upliftment. The development of agreements in cooperation with communities as part of a transparent process for nominating and implementing community projects. |
| <b>Governance</b>          |                                                                                                                                                                                                                                                                                                                                                      |
| Legal compliance           | No indication of any breaches of law found. EIA completed and EIS (environmental impact statement) submitted to Department of Environmental Affairs DEA July 2023,                                                                                                                                                                                   |
| Management practices       | Comprehensive and structured information on ESG policies and management. Reference and commitment to international industry practice (e.g. GBA Battery passport, IFC Performance Standards);                                                                                                                                                         |
| Transparency and reporting | Listed on the TSXV; extensive information for investors, reports on financial accounts and shareholder structure available                                                                                                                                                                                                                           |
| Business ethics            | Botswana scores 59/100 and ranks 39/180 in the corruption perception index; Botswana is not an EITI country.                                                                                                                                                                                                                                         |

Table 36. ESG features of K.Hill project, Botswana

#### 4.7.4 Further reading

Giyani Metals Corp. (2023a): K.Hill Battery-Grade Manganese Project Preliminary economic assessment – National Instrument 43-101 Technical Report.

<https://giyanimetals.com/investors/technical-reports> (accessed 08.01.2024)

Giyani Metals Corp. (2023b): Annual Information Form for the fiscal year ended December 31, 2022. <https://giyanimetals.com/investors/financial-reports/download?path=Giyani%2B-%2B2022%2BAIF%2BFinal.pdf> (accessed 08.01.2024)

Giyani Metals Corp. (2023c): Corporate presentation – Developing low carbon battery grade manganese, December 2023.

<https://giyanimetals.com/media/attachments/2023/12/06/giyani-corporate-presentation---december-final.pdf> (accessed 08.01.2024)

## 4.8 Kanyika Nb (-Ta) alkaline granite project (Malawi)

Information as of 09/2023

### 4.8.1 General project background

|                                    |                                                                                                                                                                                                |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Niobium                                                                                                                                                                                        |
| <b>Other commodities</b>           | Uranium, tantalum                                                                                                                                                                              |
| <b>Location</b>                    | Mzimba, Malawi<br>12°42' S, 33°40' E, 950 – 1050 m.a.s.l.                                                                                                                                      |
| <b>License type</b>                | Mining license LML0216/21                                                                                                                                                                      |
| <b>License owner / operator</b>    | Globe Metals & Mining Ltd. (public company)                                                                                                                                                    |
| <b>Contact</b>                     | 45 Ventnor Avenue, West Perth,<br>Western Australia 6005, Australia<br><a href="https://www.globemm.com">https://www.globemm.com</a><br><a href="mailto:info@globemm.com">info@globemm.com</a> |
| <b>Project status</b>              | Feasibility completed, improved Feasibility in progress                                                                                                                                        |
| <b>Possible production by 2030</b> | Announced for 2024; a certain delay might be expected, but production by 2030 appears possible                                                                                                 |

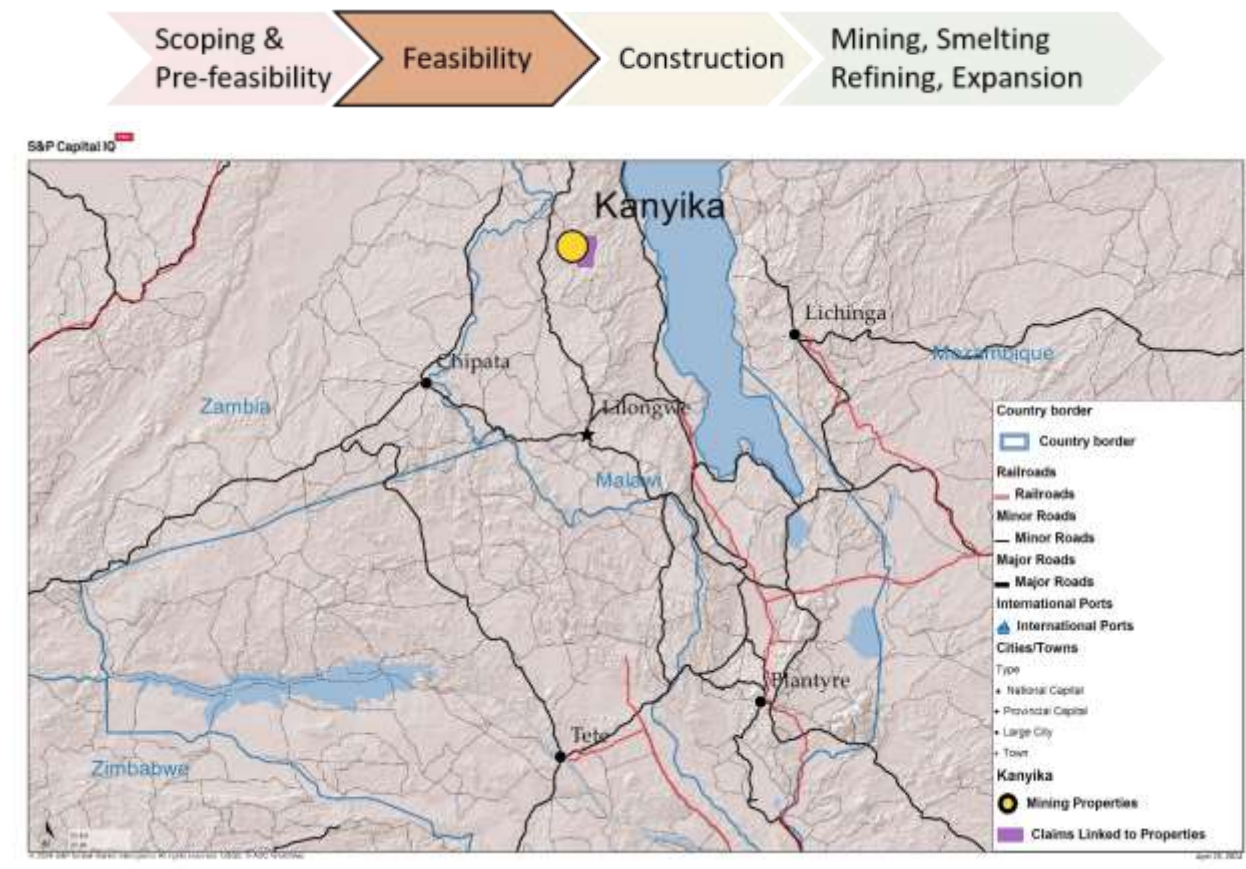


Figure 27. Kanyika project location, Malawi

## 4.8.2 Economic assessment

### General project background:

Kanyika is a pyrochlore (niobium, tantalum)-zircon-uranium deposit with prospecting beginning in 2006. The mineralisation is hosted within a NNE striking, westerly dipping alkali granite in concordance with the surrounding biotite gneiss. The deposit lies on the western flank of a regional fold associated with the alkali granite. The granite can be traced for about 15 km and is several hundred meters wide. Outcrops of this granite cover a strike length of 2.5 km with an average width of 200 m in the south and 50 m in the north. The ore body (weathered alkali granite) is steeply dipping, has a maximum depth of 160 m and can be classified into 3 vertical domains, namely the saprock, transition and fresh rock domains. These domains have overall constant pyrochlore mineralisation. GlobeMM is the first company to execute a Mining Development Agreement (MDA) with the Malawi Government since the enactment of the Mines & Minerals Act, 2018. The owner seeks investment to finalise the design and cost estimates for the phase 1 mine and processing plant, which includes another Feasibility Study focussing on processing improvements (significant reductions of CAPEX, OPEX and CO<sub>2</sub> emissions); for constructions related to phase 1 as well as for the phase 2 full-scale operations.

### Project description:

|                                               |                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                              | Granite-hosted pyrochlore deposit                                                                                                                                                                                                                                                                              |
| JORC compliant Reserves                       | 33.8 Mt @ 3,048 g/t Nb <sub>2</sub> O <sub>5</sub> , 141 g/t Ta <sub>2</sub> O <sub>5</sub>                                                                                                                                                                                                                    |
| Share of global niobium reserves              | 0.4 % ( <i>USGS estimate global Nb<sub>2</sub>O<sub>5</sub> reserves of 24.3 Mt</i> )                                                                                                                                                                                                                          |
| Share of global tantalum reserves             | 2.8 % ( <i>USGS estimate global Ta<sub>2</sub>O<sub>5</sub> reserves of 170 kt, but only including Australia and Brazil</i> )                                                                                                                                                                                  |
| JORC compliant resources                      | 68.3 Mt @ 2,830 g/t Nb <sub>2</sub> O <sub>5</sub> , 135 g/t Ta <sub>2</sub> O <sub>5</sub>                                                                                                                                                                                                                    |
| Waste to ore ratio (whole orebody)            | 0.56 during phase 1                                                                                                                                                                                                                                                                                            |
| Annual production                             | Phase 1: 340 kt of ore, 3.6 kt of concentrate, 720 t of contained Nb <sub>2</sub> O <sub>5</sub> , 32 t of contained Ta <sub>2</sub> O <sub>5</sub><br>Phase 2: 1.5 Mt of ore, 11.9 kt of concentrate, 3.25 kt of contained Nb <sub>2</sub> O <sub>5</sub> , 140 t of contained Ta <sub>2</sub> O <sub>5</sub> |
| Life of mine                                  | 23 years (phase 1: 3 years; phase 2: 20 years)                                                                                                                                                                                                                                                                 |
| Investment required                           | US\$ 420m (for phase 1 & 2 full production)                                                                                                                                                                                                                                                                    |
| Net present value (NPV; phase 2)              | US\$ 1bn (based on 8 % discount rate)                                                                                                                                                                                                                                                                          |
| Share of global niobium production (phase 2)  | 3.0 % (recovery 70 %)<br>( <i>USGS estimate global Nb<sub>2</sub>O<sub>5</sub> production of 107 kt</i> )                                                                                                                                                                                                      |
| Share of global tantalum production (phase 2) | 5.5 % (recovery 75 %)<br>( <i>USGS estimate global Ta<sub>2</sub>O<sub>5</sub> production of 2,560 t</i> )                                                                                                                                                                                                     |

### Mining and processing:

- Conventional open pit methods employing free dig mining (load and haul) and subsequent crushing, milling, flotation and drying of pyrochlore-bearing ore. The pyrochlore concentrate, which contains 40 % Nb and 1 % Ta as well as radioactive nuclides, is packed into bags and loaded onto flat bed trucks for sale and transport to the GlobeMM-owned refinery in



Namibia. The refinery comprises electrolysis of salt to produce chlorine, chlorine recycling from oxidation and reduction, metal conversion to gaseous chlorides at high temperature and subsequent selective cooling for primary separation of metal chlorides, distillation and purification (>99 % achievable) to metal oxides.

- The operating expenditures are given at US\$ 5,850/t of concentrate including costs for mining, processing to a concentrate and refining to bulk finished products at recoveries up to 75 % due to GlobeMM's patented refinery methods. These costs face expected revenues of US\$ 20,500/t of produced concentrate. The company anticipates that Japan, the greater Europe region, Russia and the Americas will be a significant focus in sales agreements.

#### **BGR assessment and comments:**

- The deposit is a low-grade, high-tonnage operation with a low waste to ore ratio of 0.56 during Phase 1. The relatively long estimated life of mine (23 years) can be positive for the development of the region. The project has the capability to extend this to 38 years, subject to the conversion of inferred resources through further drilling.
- GlobeMM assumes high Nb<sub>2</sub>O<sub>5</sub> and Ta<sub>2</sub>O<sub>5</sub> prices of US\$ 55/kg and US\$ 410/kg, respectively. Currently, average Nb<sub>2</sub>O<sub>5</sub> prices are US\$ 41.5/kg and US\$ 51.5/kg referring to purities of 99.5% and 99.99 % FOB China. The Ta<sub>2</sub>O<sub>5</sub> (min. 99.5 %) prices averaged US\$ 428/kg on the US spot market during the last 3 years. It is advised to consider lower Nb<sub>2</sub>O<sub>5</sub> prices for the project evaluation and it should be mentioned that there is not yet any precise information on the purity of the final refined oxides. With niobium as the major commodity (85 % of overall production), the project would face difficulties to profitably extract the complete resource when Nb<sub>2</sub>O<sub>5</sub> prices decline.
- The Kanyika niobium deposit is located in northern Malawi, ~250 km north of Lilongwe and ~55 km north-east of Kasungu. The site is serviced by 29 km of poor-quality gravel road, which is to be upgraded for use by heavy vehicles and accesses the main Malawian M1 highway at the trading centre of Chatoloma. The M1 provides good, fully sealed road access south through the capital of Lilongwe. GlobeMM approached C. Steinweg Group to commission the transport of the Class 7 concentrate (hazardous radioactive material) from Kanyika via Johannesburg to the project refinery in Walvis Bay, Namibia. Water is planned to be sourced by diversion of the Milenje and Chimwa Rivers around the pit, accompanied by constructing water storage facilities, and re-join the river channel downstream. There is an agreement with the government on the grid power supply. Further power is planned to be sourced by in-house solar and hydropower as well as diesel power generation.



### 4.8.3 ESG assessment

GlobeMM's operation planning and management approach appears in general sufficient to handle ESG risks. Two issues for consideration were identified: The produced concentrate shows elevated radioactive activity and is classified as Class 7 material, with the related risks and needs for special permits for cross border and port infrastructure for overseas transport. News reports on anxiety and grievances in local communities with regard to resettlement actions indicating shortcomings in stakeholder engagement in the past. These are due to prolonged uncertainty on necessary resettlements, starting with exploration 16 years ago (see Mongabay (2023)). Special effort to gain the trust of local communities may be needed.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Environmental management                                           | Environmental Management Plan submitted; US\$ 5M environmental performance fund provided; no reports on incidents found.                                                                                                                                                                                                                                                                                                                                                                   |
| Efficient use of energy, renewable energy, GHG emissions reporting | Current operation planning: 2.3 Ml/a fuel requirement; 80,000 MWh/a, 19.5 MW electrical energy requirement from Malawian grid. Assessment of third party regenerative power supply ongoing, implementation is stated as highly probable.                                                                                                                                                                                                                                                   |
| Water management and consumption                                   | Sub-tropic dry climate; low water stress; wet season from November to April; extremely high riverine flood risk; stormwater control designed for 100-year Average Recurrence Interval rainfall event. Local groundwater resources insufficient; surface water storage facility is required (2.5 Mm <sup>3</sup> reservoir capacity); process water recycling targeted where possible. Diversion of Milenje River necessary for open pit construction.                                      |
| Pollution prevention                                               | The produced concentrate showing elevated radioactive activity due to Uranium content, counts as Class 7 material for transportation. AMD potential of the ore is stated as low. Flotation technology may imply use of hazardous reagents.                                                                                                                                                                                                                                                 |
| Air quality                                                        | Natural Uranium content requires effective dust prevention; the concentrate is packed in containers at the mine site for transportation to the port, to prevent dust emissions and radiation exposure.                                                                                                                                                                                                                                                                                     |
| Tailings management                                                | TSF for ~33.4 Mt of flotation residues; design according to International Commission on Large Dams and Australian National Committee on large Dams standards; tailings will be thickened before deposition. The description of the tailing dam design is indicating an upstream type dam. Instances of catastrophic failure have been relatively more common at upstream-type dams, however upstream facilities require rigorous tailings management implementation to be operated safely. |
| Waste management                                                   | Dedicated waste dump for 53 Mt of waste rock; planned with run-off capturing for surface water. Conventional landfill for facility waste.                                                                                                                                                                                                                                                                                                                                                  |
| Hazardous materials management                                     | Flotation and use of required reagents is considered low risk assuming responsible handling; no information on used reagents available.                                                                                                                                                                                                                                                                                                                                                    |
| Noise and vibration                                                | Proximity to neighbouring settlements requires effective noise protection measures; construction of noise protection wall from mine waste planned.                                                                                                                                                                                                                                                                                                                                         |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Protected areas and biodiversity                          | Woodland savannah with advanced deforestation due to agricultural and forestry activities; the project is not located in or close to a key biodiversity area or other designated protected area.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Mine closure                                              | Details on current mine closure planning were not available; GlobeMM aims for a detailed plan within the first five years of operation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Community health, safety and security                     | Rural area with; majority of population are subsistence farmers. Several smaller settlement in and around mining area require effective measures to prevent negative impact on local population.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Dialogue and engagement with communities and stakeholders | ESIA committing GlobeMM to engagement with local communities and authorities. GlobeMM maintains half-yearly consultations with local communities; indication of insufficient engagement in case of relocation (see “Land acquisition and involuntary resettlement”).                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Land acquisition and involuntary resettlement             | Approved Resettlement policy Framework part of the ESIA; changes in Malawian legislation will require adjustment of published policy. Relocation of around 250 homesteads / 1,400 people required; there are, however, news reports on dissatisfaction and grievance in local communities (see Mongabay (2023)). Heritage and Cultural Impact Assessment identified several graveyards and Iron Age heritage sites to be preserved or relocated in consultation with the communities.                                                                                                                                                                                                   |
| Occupational health & safety management                   | No specific information on OHS management available at this stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Workers' rights                                           | Malawi scores 68/100 in the Labour Rights Index. No indication of non-compliance with fundamental workers' rights by GlobeMM found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Gender and diversity                                      | No specific information on diversity policies available at this stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Local value added and community development               | Social Responsibility Plan approved by government. GlobeMM estimates a workforce of 150 direct employed and 50 contract workers and a casual workforce of around 200; indirect job creation is estimated at 10,000, which appears quite high. Due to lack of skilled workers, GlobeMM assumes to rely on a high share of expatriate workers in the beginning and is planning to train locals during operation for gradual replacement. GlobeMM is committed to provide drinking water for local communities; preferably procure goods and service locally. 10 % non-diluting equity interest and 5 % royalties for the Malawian government; 0.45 % royalties for the Kanyika community. |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Legal compliance                                          | Approved ESIA for roadwork and mining operations in accordance with Malawian Environment Management Act, EIA Guidelines, and EIA Guidelines for Mining Projects. No indication of any breaches of law found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Management practices                                      | CSR Statement in alignment with OECD guidelines, EITI guidelines, and Equator Principles.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Transparency and reporting                                | Listed on the ASX; information on financial accounts and shareholder structure available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

| ESG category    | Assessment                                                                                                                                                                                                                                     |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Business ethics | Malawi scores 34/100 in the Corruption Perception Index; Malawi is an EITI country. No indication of unethical practice from GlobeMM found. Adopted Australia Africa Mining Industry Group Anti-Bribery and Corruption Compliance Obligations. |

Table 37. ESG features of Kanyika project, Malawi

#### 4.8.4 Further reading

Globe Metals & Mining (2021): Kanyika Niobium Project – Project Feasibility and Economics. [https://cdn-api.markitdigital.com/apiman-gateway/ASX/asx-research/1.0/file/2924-02409030-6A1046293?access\\_token=83ff96335c2d45a094df02a206a39ff4](https://cdn-api.markitdigital.com/apiman-gateway/ASX/asx-research/1.0/file/2924-02409030-6A1046293?access_token=83ff96335c2d45a094df02a206a39ff4) (accessed: 07.09.2023)

Globe Metals & Mining (2023a): Niobium. Critical for safe, ultra-fast battery charging. <https://announcements.asx.com.au/asxpdf/20230804/pdf/05sb6f7x7zj109.pdf> (accessed: 07.09.2023)

Globe Metals & Mining (2023b): An overview of the Kanyika niobium mine project in Malawi. [https://www.researchgate.net/publication/370003123\\_AN\\_OVERVIEW\\_OF\\_THE\\_KANYIKA\\_NIOBIUM\\_MINE\\_PROJECT\\_IN\\_MALAWI](https://www.researchgate.net/publication/370003123_AN_OVERVIEW_OF_THE_KANYIKA_NIOBIUM_MINE_PROJECT_IN_MALAWI) (accessed: 08.09.2023)

Mongabay (2023): Australian niobium mining project instills 16 years of anxiety for Malawi communities. <https://news.mongabay.com/2023/01/australian-niobium-mining-project-instills-16-years-of-anxiety-for-malawi-communities/> (accessed: 22.09.2023)

## 4.9 Karibib Li (-Rb-Cs-Ta) pegmatite project (Namibia)

Information as of 05/2023

### 4.9.1 General project background

|                                    |                                                                                                                                                                                                   |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Lithium                                                                                                                                                                                           |
| <b>Other commodities</b>           | Caesium, rubidium, potassium                                                                                                                                                                      |
| <b>Location</b>                    | Erongo region, Namibia<br>22°1' S, 15°55' E, 1300 – 1350 m.a.s.l.                                                                                                                                 |
| <b>License type</b>                | Mining license ML 204 (68.7 km <sup>2</sup> )                                                                                                                                                     |
| <b>License owner / operator</b>    | Lepidico Ltd. (public company)                                                                                                                                                                    |
| <b>Contact</b>                     | 680 Murray Street, Suite 2<br>West Perth, Western Australia 6005, Australia<br><a href="http://www.lepidico.com">www.lepidico.com</a><br><a href="mailto:info@lepidico.com">info@lepidico.com</a> |
| <b>Project status</b>              | Preproduction, construction planned                                                                                                                                                               |
| <b>Possible production by 2030</b> | Announced for 2024; certain delay might be expected, but production by 2030 appears possible                                                                                                      |

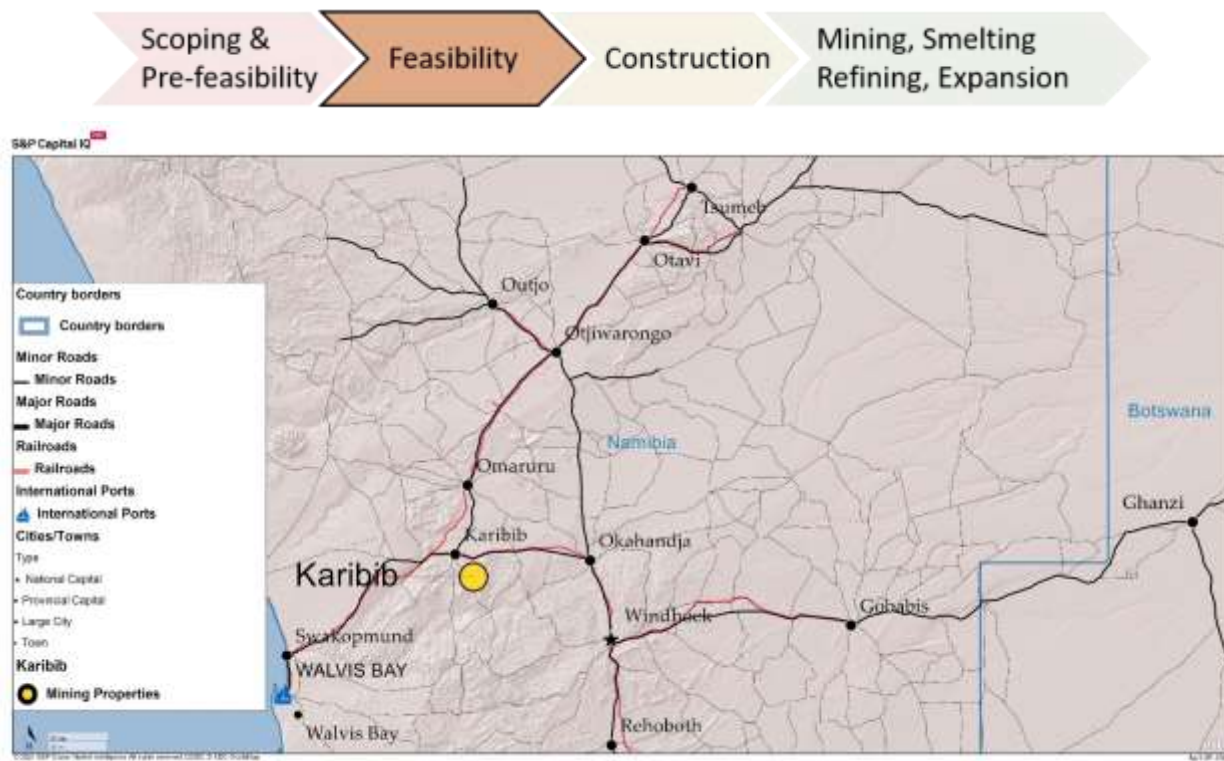


Figure 28. Karibib project location, Namibia

## 4.9.2 Economic assessment

### General project background:

The Karibib project mainly focuses on lepidolite mining from three Li-Cs-Ta pegmatites, namely Rubicon, Helikon 1, and Helikon 4. The orebodies were historically mined (since the 1950s) for petalite, amblygonite, beryl, quartz and accessory pollucite and bismuth on a small scale, retaining lepidolite-enriched tailings and stockpiles. The thickness of the mineralised pegmatite sills ranges from 5 to 35 m. The orebodies are dipping at 20-30° (Rubicon) and 50-70° (Helikon 1 and 4), leading to an increase in the waste to ore ratio with depth. The Definitive Feasibility Study has been completed in 05/2020. The project operator Lepidico Ltd. seeks US\$ 63m investment for mine and concentrator constructions and US\$ 203m for the construction of a Lepidico-owned chemical plant to be built in the United Arab Emirates (UAE).

### Project description:

|                                    |                                                                                                                             |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Pegmatite                                                                                                                   |
| JORC compliant reserves            | 9.43 Mt @ 0.43 % Li <sub>2</sub> O, 2,101 g/t Rb, 278 g/t Cs, 2.00 % K                                                      |
| Share of global lithium reserves   | 0.1 % ( <i>USGS estimate global Li<sub>2</sub>O reserves of 56 Mt</i> )                                                     |
| JORC compliant resources           | 5.10 Mt @ 0.52 % Li <sub>2</sub> O, 88 g/t Rb, 220 g/t Cs, 1.00 % K                                                         |
| Share of global lithium resources  | 0.01 % ( <i>BGR estimate* global Li<sub>2</sub>O resources of 211 Mt</i> )                                                  |
| Waste to ore ratio (reserves only) | 2.8 for 9.43 Mt                                                                                                             |
| Annual production                  | 0.52 Mt of ore, 2,240 t of contained Li <sub>2</sub> O                                                                      |
| Life of mine                       | 19 years                                                                                                                    |
| Investment required                | US\$ 266m (US\$ 203m for the chemical plant in UAE, US\$ 63m for the Karibib mine and concentrator including contingencies) |
| Net present value (NPV)            | US\$ 530m (assuming long-term LiOH prices of US\$ 17,015/t and 8 % discount rate)                                           |
| Share of global lithium production | 0.8 % (2,240 t Li <sub>2</sub> O/a)<br>( <i>USGS estimate global Li<sub>2</sub>O production of 280,000 t</i> )              |
| Value addition potential           | The main and economic by-products are produced in the UAE and are therefore not part of Namibian value chains.              |

### Mining and processing:

- Conventional open pit methods employing drilling, blasting, and hauling over three pegmatite sills, namely Rubicon, Helikon 1, and Helikon 4 and reclamation of existing tailings and stockpiles. Ore will be beneficiated by crushing, grinding, and flotation on site to produce a lithium-rich concentrate consisting mainly of the lithium bearing mineral lepidolite (Li recovery ore to concentrate: 80.1 %). Ore-types include massive lepidolite (~1.80 % Li contained), disseminated lepidolite (~1.36 % Li contained), and other lithium-bearing mica (e.g., zinnwaldite) and pegmatite ore (~1.17 % Li contained). The lepidolite concentrate will be transported to Lepidico's Lithium Chemical Plant to be built in the UAE and to be treated in Lepidico's patented LOH-Max®, L-Max® and S-Max® processes to produce battery-grade lithium hydroxide or lithium carbonate (Li recovery concentrate to LiOH·H<sub>2</sub>O: 89 %).

- The mining plan envisages an ore production rate of 0.52 Mt/a with a relatively low average waste to ore ratio of 2.5 (for 9.43 Mt of reserves). The waste to ore ratio will increase as mining progresses into the deeper parts of the orebody.
- The operating costs comprise US\$ 376/t and logistics comprise US\$ 147/t concentrate (FOB Walvis Bay). Lepidico assumes long-term LiOH prices of US\$ 17,015/t combined with saleable by-products, including, during the life of mine (19 years): 653,000 t amorphous silica (US\$ 50/t), 180,000 t sulphate of potash (US\$ 530/t), and 4,000 t caesium brine (US\$ 25,000/t).

#### **BGR assessment and comments:**

- The deposit is a medium-grade, low-tonnage operation with a relatively low waste to ore ratio of 2.5. The relatively long life of mine (19 years) supports long-term employment of the regional mining-related labour force, which is already established due to the much larger Navachab Gold Mine (operated since 1989). The existence of active large mining operations already provides supply chains, skills, and resources. Resource expansions are possible due to the occurrence of many pegmatites in the vicinity, which have not yet been tested for mineralisation.
- Lepidico assumes moderate long-term LiOH prices of US\$ 17,015/t; this price assumption is highly sensitive to the profitability of the project. Especially for the deeper parts of the resource, with a lower Li-grade, a higher waste to ore ratio and the associated higher diesel consumption, the project may face difficulties to profitably extract the complete resource in case LiOH prices decline.
- The LOH-Max<sup>®</sup> process has never been applied on a commercial scale. The recoveries, consumables and costs in Lepidico's production and financial models are derived from extensive bench scale testing and continuous pilot plant operation processing.
- The Karibib project is located south of the small town of Karibib (~5,000 inhabitants), which is connected to the next port in Walvisbay (~210 km) by paved road and a railway line. However, the local roads connecting the Karibib project with the town of Karibib will need enhancements. Electrical power is expected to be supplied from the Nampower grid after the construction of an overhead line. Water is expected to be sourced locally from the ground under license with greater than 85% of process water to be recycled.



### 4.9.3 ESG assessment

The level of publicly available project information is good and no major ESG issues were identified. The company's corporate policies and management systems appear sufficient to prevent conflicts related to the mining operations. Reclamation and rehabilitation of abandoned mine sites might actually improve the local situation.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                            |
| Environmental management                                           | One low impact environmental incident without lasting effect in 2022 (scrub fire induced by machinery); acquiring of fire and water trailers against future scrub fires, which also will service the local community.                                                                                                                                      |
| Efficient use of energy, renewable energy, GHG emissions reporting | Phase 1 aggregate Scope 1 and 2 emissions determined less than 3 t CO <sub>2</sub> -eq/t Lithium Carbonate Equivalent (LCE); reducing Scope 1 by electrification of leased hauling trucks is envisaged. ~80 % of regional grid power renewable by 2025; potential additional regional solar projects could allow 100 % (except backup diesel).             |
| Water management and consumption                                   | Project site in arid area with low water use. 33 m <sup>3</sup> /t LCE, 85% of water recycled; 80,000 m <sup>3</sup> - 210,000 m <sup>3</sup> permitted to be extracted from groundwater annually (sufficient for doubling of production). Data indicating aquifer regeneration exceeding extraction; aquifer monitoring will be employed to confirm this. |
| Pollution prevention                                               | Tailings and waste are both regarded as ecologically harmless. Flotation technology may imply use of hazardous reagents.                                                                                                                                                                                                                                   |
| Air quality                                                        | Remoteness of site location does not indicate general need for special measures.                                                                                                                                                                                                                                                                           |
| Tailings management                                                | Tailings co-disposal with mine waste, no dedicated tailing storage facility planned.                                                                                                                                                                                                                                                                       |
| Waste management                                                   | Waste disposal areas planned at both project sites.                                                                                                                                                                                                                                                                                                        |
| Hazardous materials management                                     | Flotation and use of required reagents is considered low risk assuming responsible handling.                                                                                                                                                                                                                                                               |
| Noise and vibration                                                | Conventional drilling and blasting operation; considered low risk due to remote site location.                                                                                                                                                                                                                                                             |
| Protected areas and biodiversity                                   | The project is not located in or close to any key biodiversity areas or other designated protected areas. Mine plan includes reclamation and rehabilitation of abandoned mine sites.                                                                                                                                                                       |
| Mine closure                                                       | Mine closure plan (2020 draft was reviewed) appears comprehensive and reasonable. The company is committed to assess the mine closure costs on annually base and reserve appropriate financial resources.                                                                                                                                                  |
| <b>Social and socio-economic issues</b>                            |                                                                                                                                                                                                                                                                                                                                                            |
| Community health, safety and security                              | Scarcely populated area; mine site in the vicinity of the town of Karibib (~5,000 inhabitants, ~13,300 in the constituency); few smaller settlements in or close to the mining area; distance to the nearest major settlements appears large enough that the potential negative impact on the local population is generally considered low risk.           |



| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dialogue and engagement with communities and stakeholders | No detailed information on structure of stakeholder engagement available; information on CSR measures etc. indicating functional engagement approach by the company.                                                                                                                                                                                                                          |
| Land acquisition and involuntary resettlement             | Land use agreement in development with the government; resettlement of smaller settlements might be necessary.                                                                                                                                                                                                                                                                                |
| Occupational health & safety management                   | Established OHS Policy and OHS Management Plan; zero recordable OHS incidents in 2022.                                                                                                                                                                                                                                                                                                        |
| Workers' rights                                           | Namibia scores 68.5/100 in the Labour Rights Index. No indication of non-compliance with fundamental workers' rights found.                                                                                                                                                                                                                                                                   |
| Gender and diversity                                      | Company assessed as top 5 % ASX listed companies in terms of diversity in key management positions; share of women in the overall workforce 30 %.                                                                                                                                                                                                                                             |
| Local value added and community development               | Company states job creation as around 115 directly and 800 indirectly; mine life of 19 years allowing longer-term development opportunities. CSR plan comprises agricultural support program, entrepreneurship workshops for women and youth, and provision of the mine sites fire and water trailers for community service; funding of a maternity ward in a nearby clinic planned for 2023. |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                               |
| Legal compliance                                          | No indication of any breaches of law found. Water extraction permit and Environmental Compliance Certificate granted; Environmental and Social Impact Assessment completed.                                                                                                                                                                                                                   |
| Management practices                                      | Corporate Governance Statement in compliance with ASX Principles of Good Corporate Governance and Best Practice Recommendations.                                                                                                                                                                                                                                                              |
| Transparency and reporting                                | Listed on the Australian Security Exchange (ASX); information for investors, reports on financial accounts and shareholder structure available. Adopted reporting frameworks: International Finance Corporation (IFC) performance standards, Equator principles. Working towards Initiative for Responsible Mining Assurance (IRMA) and Global Reporting Initiative (GRI) standard.           |
| Business ethics                                           | Namibia scores 49/100 in the corruption perception index; Namibia is not an EITI country; no indication of unethical practices found.                                                                                                                                                                                                                                                         |

Table 38. ESG features of Karibib project, Namibia

#### 4.9.4 Further reading

Edison Investment Research (2022): Lepidico – Valuation update post-feasibility study.

<https://www.edisongroup.com/research/valuation-update-post-feasibility-study/27309/>

(accessed 16.04.23)

Lepidico (2022a): Annual Report 2022 – Sustainable Chemicals for the Future.

[https://cdn.lepidico.com/production/LPD\\_221018\\_Annual\\_Report\\_to\\_shareholders\\_c2dd1f181a.pdf](https://cdn.lepidico.com/production/LPD_221018_Annual_Report_to_shareholders_c2dd1f181a.pdf) (accessed 16.04.23)

Lepidico (2022b): Financial Report 2022.

[https://cdn.lepidico.com/production/LPD\\_220923\\_Full\\_Year\\_Statutory\\_Accounts\\_b712c85a79.pdf](https://cdn.lepidico.com/production/LPD_220923_Full_Year_Statutory_Accounts_b712c85a79.pdf) (accessed 12.05.23)

Lepidico (2023a): Announcement – Phase 1 Economics Updated & Improved.

[https://cdn.lepidico.com/production/LPD\\_221122\\_Phase\\_1\\_Economics\\_Updated\\_and\\_Improved\\_8b12e1b265.pdf](https://cdn.lepidico.com/production/LPD_221122_Phase_1_Economics_Updated_and_Improved_8b12e1b265.pdf) (accessed 16.04.23)

Lepidico (2023b): Announcement – Helikon 4 maiden Ore Reserve extend Phase 1 life.

[https://cdn.lepidico.com/production/230213\\_Helikon\\_4\\_maiden\\_Ore\\_Reserve\\_extends\\_Phase\\_1\\_life\\_7e7282ff3a.pdf](https://cdn.lepidico.com/production/230213_Helikon_4_maiden_Ore_Reserve_extends_Phase_1_life_7e7282ff3a.pdf) (accessed 09.05.23)

## 4.10 Longonjo (Ozango) REE carbonatite project (Angola)

Information as of 04/2023

### 4.10.1 General project background

|                                    |                                                                                                                                                                                                                 |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Light REEs                                                                                                                                                                                                      |
| <b>Other commodities</b>           | Heavy REEs                                                                                                                                                                                                      |
| <b>Location</b>                    | Huambo Province, Angola<br>12°54' S, 15°14' E, 1750 – 1800 m.a.s.l.                                                                                                                                             |
| <b>License type</b>                | Environmental installation license (31 km <sup>2</sup> )<br>Mining permit (until 2035, renewable up to 2055)                                                                                                    |
| <b>License owner / operator</b>    | 84 % Pensana Plc (public company)<br>16 % governmental companies                                                                                                                                                |
| <b>Contact</b>                     | 107 Cheapside, Suite 31, Second Floor<br>London EC2V 6DN, United Kingdom<br><a href="https://www.pensana.co.uk/">https://www.pensana.co.uk/</a><br><a href="mailto:admin@pensana.co.uk">admin@pensana.co.uk</a> |
| <b>Project status</b>              | Feasibility study completed (08/2022)                                                                                                                                                                           |
| <b>Possible production by 2030</b> | Announced for 2025; certain delay might be expected,<br>but production by 2030 appears possible                                                                                                                 |



Figure 29. Longonjo project location, Angola

### 4.10.2 Economic assessment

#### General project background:

The Longonjo project is hosted by the Longonjo carbonatite diatreme (~2.5 km in diameter), which comprises near-surface high-grade colluvium and weathered carbonatite of up to 50 m in thickness, underlain by fresh carbonatite. The carbonatite is located within the NE-trending Lucapa Lineament in central Angola, which hosts numerous economic carbonatites and kimberlites. The feasibility study for the Longonjo project was completed in Aug 2022 and assumes annual production of 40,000 t of high-grade mixed rare earth double sulphate (MREDS). The owner is seeking investment for the construction of the concentrator plant, the MREDS plant, the establishment of the mine site, and infrastructure improvements, i.e., the construction of a rail line connecting the mine site to the adjacent railroad (~4 km) and connection to the national power grid (~45 km).

#### Project description:

|                                    |                                                                                                                                                                                 |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Carbonatite (weathered)                                                                                                                                                         |
| JORC compliant reserves            | 30.1 Mt @ 2.37 % LREO, 2.55 % REO                                                                                                                                               |
| Share of global REO reserves       | 0.6 % ( <i>USGS estimate global REO reserves of 120 Mt</i> )                                                                                                                    |
| JORC compliant resources           | 313 Mt @ 1.43 % REO (reserves included)                                                                                                                                         |
| Waste to ore ratio (whole orebody) | Initially low due to surface-weathered material mining                                                                                                                          |
| Annual production                  | 1.6 Mt of ore, 40,000 t MREDS product                                                                                                                                           |
| Life of mine                       | >20 years                                                                                                                                                                       |
| Investment required                | US\$ 305m (for mine and processing plant)                                                                                                                                       |
| Net present value (NPV)            | US\$ 2.2bn (assuming NdPrO price of US\$ 150/kg and 8 % discount rate)                                                                                                          |
| Share of global REO production     | Not defined for MREDS product at Longonjo,<br>4.5 % produced at Pensana-owned Saltend (UK) refinery<br>(12,500 t/a) ( <i>USGS estimate global REO production of 280,000 t</i> ) |
| Value addition potential           | No REE refinery in Angola available; saleable high purity lanthanum and cerium as well as minor heavy rare earth products from Saltend refinery                                 |

#### Mining and processing:

- Four geometallurgical domains include colluvium, saprolite, saprock, and fresh carbonatite. The open pit free dig mining of weathered material will result in a very low waste to ore ratio (during the first 5 years) and will be performed by track-mounted down-the-hole or top hammer drill rigs, loaded by small hydraulic excavators, and hauled with articulated haul trucks. Blasting is planned only for fresh rock mining in later stages of the mine life.
- Mineral processing at the Longonjo plant facilities will include grinding, flotation, leaching, calcining, and solids/liquids separation. Pensana describes the recoveries as follows: ~41 % ore to concentrate; 70 % concentrate to MREDS product; 90-95 % MREDS product to final product (from Saltend refinery).

- The annual operating expenditures are given at US\$ 3,943/t MREDS product for the first 5 years (2026-2030) at full production. The bulk of MREDS product offtake will be shipped to the Pensana-owned Saltend (UK) refinery, which requires another investment of US\$ 197m (general CAPEX) for their separation facility. The annual operating expenditures at Saltend are given at US\$ 17/kg NdPrO product, with an expected revenue of US\$ 150/kg NdPrO product.

### **BGR assessment and comments:**

- The deposit is a medium-grade, medium-tonnage REO project with a low waste to ore ratio due to the near-surface location of the mineralisation. It is important to note that Pensana's reserves and resources estimates include fresh rock-hosted mineralisation. In case of fresh rock mining (including blasting) in the deeper areas of the open pit, it is likely that both the waste to ore ratio and the operational costs will increase.
- The relatively long life of mine (>20 years) can be positive for the development of the region, which will include the employment of local skilled and unskilled workers directly at the mine site, if available, but also for infrastructural improvements.
- The size of the carbonatite diatreme (2.5 km diameter, >150 m thickness) and the current state of exploration hold the potential to expand resource estimates through brownfield investigations.
- The recovery rate of only 29 % from ore to MREDS is assumed to be very low. Especially the recovery of only 40 % to the concentrate might pose a risk to the project due to inefficient metallurgical processes.
- Pensana based the feasibility of Longonjo on the NdPrO product that the company will produce at their own refinery in Saltend (UK). They assume high long-term NdPrO sell prices of US\$ 150/kg and above. The average NdPrO price for the last 5 years were ~US\$ 125/kg, with two significant increases in 2021 and 2022, respectively, which reflect the high volatility of REO prices. These assumptions imply a high risk, not only for the NPV, but also for the financial viability.

### 4.10.3 ESG assessment

The company developed an ESG strategy differentiating three phases of project development. Detailed information on the specific management of several ESG issues are not yet specified, the commitments from the ESG strategy are ambitious and generally appear reasonable. Special attention shall be given to radioactive waste treatment and disposal.

| ESG category                                                                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                             |
| Environmental management                                                                                           | No reports on incidents found. Environmental and social impact assessment (ESIA) completed in 2022; ISO 14001 certification is short-term goal.                                                                                                                                                                                                                                             |
| Efficient use of energy, renewable energy, GHG emissions reporting                                                 | Regular disclosure of scope 1, 2 and 3 emission is aimed for operation phase; assessment of baseline data done. Construction of power line will allow use of renewable energy from national grid (savings from electrified kiln alone 25,000 t CO <sub>2</sub> -eq/a); no information on specific supply agreement yet. Achieving net zero in the entire value chain is targeted till 2040. |
| Water management and consumption                                                                                   | Located in area with low water stress; specific information on water consumption during the operational phase were not available. Low to medium riverine flood risk.                                                                                                                                                                                                                        |
| Pollution prevention                                                                                               | Th/U content in REE deposits implies natural radioactivity and associated risks; no information on the specific content available. Natural radiation monitoring program ongoing for baseline assessment.                                                                                                                                                                                    |
| Air quality                                                                                                        | Remoteness of site location does not indicate general need for special measures. In case of tailings disposal of separated Th/U content (see “Hazardous materials management”), special care to prevent dust discharge is advisable.                                                                                                                                                        |
| Tailings management                                                                                                | The necessary tailings facility will be planned to meet the requirements of the Global Industry Standard on Tailings Management.                                                                                                                                                                                                                                                            |
| Waste management                                                                                                   | Achieving zero waste to landfill (except tailings) is targeted till 2035.                                                                                                                                                                                                                                                                                                                   |
| Hazardous materials management  | Optimization of pilot processing plants ongoing, including: flotation process water recycling and leach extraction. Refining process flow chart suggests separation of potential Th/U content on-site (scavenging ion exchange); no information on further treatment and disposal of the Th/U available yet.                                                                                |
| Noise and vibration                                                                                                | In the first five years of operation mining of the weathered zone via excavator or pick-work, followed by drilling and blasting operation; considered low risk due to remote site location.                                                                                                                                                                                                 |
| Protected areas and biodiversity                                                                                   | The project is not located in or close to a key biodiversity area or other designated protected area. The biodiversity assessment revealed a rare natural habitat of endemic bats and birds; the mining area was reduced accordingly and a monitoring program is planned during mine operation.                                                                                             |
| Mine closure                                                                                                       | The company states completion of a post mining plan that will be continuously developed throughout the life of mine; the plan was not available for review.                                                                                                                                                                                                                                 |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                       |
| Community health, safety and security                     | Mine site in the vicinity of the town of Longonjo (~23,000 inhabitants, ~91,000 in the whole municipality), no settlements in the mining area; distance to the nearest settlements appears large enough that the potential negative impact on the local population is generally considered a low risk.                                                                                                |
| Dialogue and engagement with communities and stakeholders | Stakeholder engagement plan developed, including national government, provincial government, local authorities, traditional leaders and local communities.                                                                                                                                                                                                                                            |
| Land acquisition and involuntary resettlement             | Landownership assessment finished; no relocation necessary, land acquisition affects mainly subsistence farming land. Independent development of compensation / eligibility plan and livelihood restoration plan ongoing.                                                                                                                                                                             |
| Occupational health & safety management                   | Working towards ISO 45001 certification is stated as short-term goal.                                                                                                                                                                                                                                                                                                                                 |
| Workers' rights                                           | Angola scores 72/100 in the Labour Rights Index. No indication of non-compliance with fundamental workers' rights found. Modern slavery statement in alignment of the Modern Slavery Act 2015 in place.                                                                                                                                                                                               |
| Gender and diversity                                      | Diversity policy in place. Workforce at mine site 85 % male and 15 % female; recruiting for construction currently ongoing. Board 83 % male and 17 % female.                                                                                                                                                                                                                                          |
| Local value added and community development               | Company states job creation as around 1000 during construction and 650 during operation; committed to prioritize local / national workforce for recruitment. Value addition in host country increased due to onsite MREDS refining. A sustainable agriculture development project is part of the livelihood restoration plan.                                                                         |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                       |
| Legal compliance                                          | No indication of any breaches of law found.                                                                                                                                                                                                                                                                                                                                                           |
| Management practices                                      | Comprehensive and structured information on ESG strategy and management available; risk assessment in annual report and sustainability report 2022. Adopted reporting frameworks: International Finance Corporation (IFC) performance standards, Equator principles, EU Taxonomy, UN Global Compact, Taskforce on Climate-related Financial Disclosure. ISO 14001, ISO 45001 certification envisaged. |
| Transparency and reporting                                | Listed on the London Stock Exchange; extensive information for investors, reports on financial accounts and shareholder structure available.                                                                                                                                                                                                                                                          |
| Business ethics                                           | Angola scores 33/100 in the Corruption Perception Index; Angola is an EITI country candidate. Anti-bribery and corruption policy in place. Adherence of "Principles for Sustainable Procurement" mandatory for all suppliers.                                                                                                                                                                         |

Table 39. ESG features of Longonjo project, Angola



#### 4.10.4 Infrastructure assessment

##### Potential Investment Needs:

- Water Supply: Dependant on seasonal rainfall for water supply is not ideal and therefore, borehole drilling to access groundwater present at three areas within the carbonatite will be necessary.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | The Longonjo LREE project is located in an infrastructure rich part of Angola close to modern road and rail that links to a new Atlantic port development, and recently commissioned hydropower scheme with excess low-cost power. The project lies 60 km west of Angola's second largest city – Huambo – where services, a work force and airport are all available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Transport                 | The project lies 4 km from the sealed national highway that run from the Atlantic port of Lobito 300 km to the west, to the provincial capital of Huambo.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Airport                   | Angola has 38 airports, which include domestic, international, military, and private airports. Two airports are, however, located close to the site, the Benguela Airport (located to the west) and Huambo Airport (that is 60 km to the east).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Rail access               | The Benguela Railway was reconstructed between 2006 and 2014 by the China Railway Construction Corporation at a cost of US\$ 1.83bn employing 100,000 Angolans. The railway extends from the border with the Democratic Republic of Congo and services the ports of Benguela and Lobito on the Atlantic coast of Angola. The railway is Cape gauge, 1,067 mm (3 ft 6 in), which is used by most mainline railways in southern Africa. The maximum design speed is 90 km/h. The design capacity is 20 million tons of cargo and 4 million passengers per year.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Port                      | The Port of Lobito is Angola's second busiest port and is situated on the Atlantic coast facing the centre of the country and is 30 km to the north of the large city of Benguela. Handling approximately 2 million tonnes of cargo annually, the port is also the coastal terminus of the refurbished Benguela Railway. The Angolan Government invested approximately US\$ 2bn for the rehabilitation of the Lobito port and associated infrastructure. The new rail system links directly into the dry port, container, and ore terminals at the port of Lobito. The container terminal is 414 m long, the ore terminal has a 310 m jetty, and the dry port has an area of 90,000 m <sup>2</sup> .                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Energy                    | The total electrical power requirements of the operation are 15 MW, with an average draw of 10 MW after expansion in year 4. Electrical power is ultimately planned to be supplied from the national grid powered by hydro schemes via a substation at Caala, located 40 km east of the project. During construction power can be sourced from an existing hybrid solar – diesel and potential battery supplemented generator power plant at Longonjo that currently has considerable spare capacity. The local power station, located 4 km from the project, has a capacity of 5 MW will be able to supply the approximately 1 MW required during the construction phase through a dedicated 30 kV line. The company is considering a proposal to supply start-up power to the project by temporary expansion of the hybrid power plant's generation capacity by an independent contractor at a fixed rate during the payback period in order to reduce the initial project capex requirement. For renewable energy, the new Laúca hydropower plant is in the north of the country in the middle part of the Kwanza River. Total capacity of Laúca will be |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | 2,070 MW. It supplies renewable energy to meet the rapidly growing demand of the capital, Luanda, and feeds into the national grid to the south, to the city of Huambo and to the Longonjo project 45 km away. The Longonjo project will shortly be tapping into this grid, post a final investment decision.                                                                                                                                                                                                                                                                                                                                                    |
| GHG emission | By including the new Laúca hydropower plant into the energy supply of Longonjo project as a replacement for diesel generators, carbon emissions can be further decreased. Pensana as project owner is committed to net zero GHG emission in its operations.                                                                                                                                                                                                                                                                                                                                                                                                      |
| Water        | Water requirements for the operation is seasonally dependant on rainfall and reclaimed water from the tailings storage facility that ranges from 40 to 65 l/s. Water will be recycled by filtration of process plant water and the plant's water circuit is a closed system to avoid discharge to the environment. Potential make up water could be sourced from bore fields located nearby. Water exploration completed in October 2019 has demonstrated the presence of groundwater in three areas within the carbonatite. For the study, a bore field comprising ten production bores and associated pipe and pump network is included in the cost estimates. |

**Table 40. Infrastructure assessment of Longonjo project, Angola**

#### 4.10.5 Further reading

Pensana (2019): Preliminary Feasibility Study. <https://pensana.co.uk/wp-content/uploads/2020/09/PFS-15.11.2019-1.pdf> (accessed 16.04.23)

Pensana (2022a): Annual report for the financial year ended 30 June 2022. <https://pensana.co.uk/wp-content/uploads/2022/10/Pensana-Plc-2022-Annual-Report.pdf> (accessed 16.04.23)

Pensana (2022b): The Pensana Blueprint for Sustainable Rare Earths – The ESG strategy for the development of the world's first independent and sustainable rare earth supply chain. [https://pensana.co.uk/wp-content/uploads/2022/09/Pensana Blueprint for Sustainable Rare Earths .pdf](https://pensana.co.uk/wp-content/uploads/2022/09/Pensana_Blueprint_for_Sustainable_Rare_Earths.pdf) (accessed 16.04.23)

Snowden Optiro (2022): Report for Pensana plc. Competent Person's statement for Longonjo ore reserves. Project Number DA206943. October 2022. [https://pensana.co.uk/wp-content/uploads/2022/09/SnowdenOptiro Pensana Longonjo Ore Res Statement.pdf](https://pensana.co.uk/wp-content/uploads/2022/09/SnowdenOptiro_Pensana_Longonjo_Ore_Res_Statement.pdf) (accessed 16.04.23)

## 4.11 Lumwana sediment-hosted Cu project (Zambia)

Information as of 12/2023

### 4.11.1 General project background

|                                    |                                                                                                                                                                                                                                      |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Copper                                                                                                                                                                                                                               |
| <b>Other commodities</b>           | Cobalt, uranium, gold                                                                                                                                                                                                                |
| <b>Location</b>                    | North-Western region, Zambia<br>12°14' S, 25°49' E, 1,300 – 1,450 m.a.s.l.                                                                                                                                                           |
| <b>License type</b>                | Large-scale mining licenses 8089-, 9000-, 9001-, 9002-, 9003-, and 9004-HQ-LML (350 km <sup>2</sup> , valid until 2029)                                                                                                              |
| <b>License owner / operator</b>    | Barrick Gold Corp. (public company)                                                                                                                                                                                                  |
| <b>Contact</b>                     | Brookfield Place, TD Canada Trust Tower Suite 3700,<br>161 Bay Street, Toronto, Ontario M5J 2S1, Canada<br><a href="https://www.barrick.com">https://www.barrick.com</a><br><a href="mailto:barrick@dpapr.com">barrick@dpapr.com</a> |
| <b>Project status</b>              | Production – Expansion                                                                                                                                                                                                               |
| <b>Possible production by 2030</b> | Yes                                                                                                                                                                                                                                  |

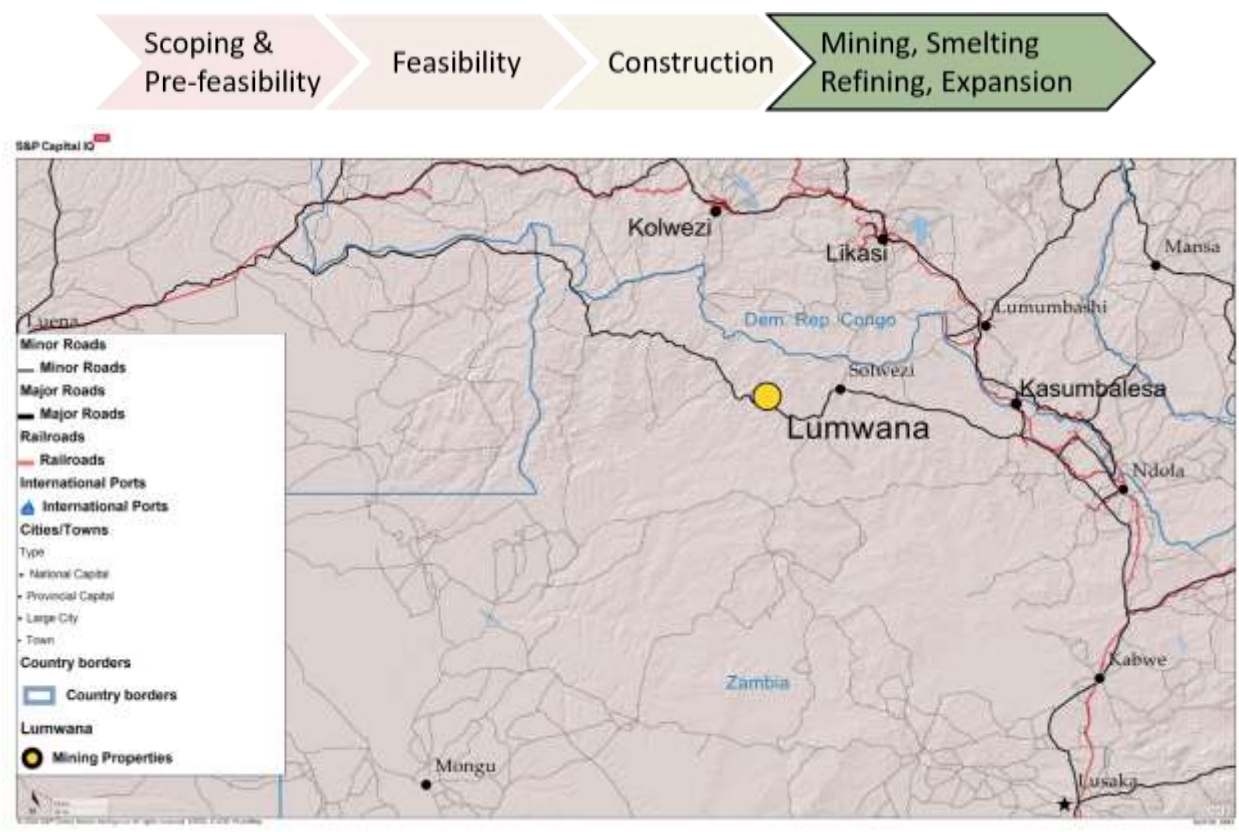


Figure 30. Lumwana project location, Zambia

### 4.11.2 Economic assessment

#### General project background:

Exploration in the Lumwana area started in the 1930s when prospectors discovered copper in the Lumwana East River. The Lumwana project contains two major copper deposits, namely Malundwe and Chimiwungo, which are structurally controlled, shear zone-hosted deposits of the Zambian Copperbelt. These copper deposits are hosted within the northeast trending Mwombezhi (basement) Dome in the western arm of the Lufilian Arc thrust fold belt. Basement units are overlain by Katangan sequences containing the copper mineralisation (chalcopyrite and bornite) within muscovite-phlogopite-quartz-kyanite schists (5 % disseminated sulphides). Copper mineralisation at Malundwe strikes ~6 km north-south and is up to 1.5 km wide (east-west), it crops out in the east, while dipping gently to the west and plunging to the south. The mineralisation at Chimiwungo currently extends up to 5.5 km north-south and 2.8 km in the east-west orientation and remains open to the east and south. Barrick targets to turn Lumwana into a Tier One project and is currently working on a prefeasibility study (to be completed in Q4/2024) for a “Super Pit”. The Super Pit expansion focusses on the integration of the Chimi Super Pit with the Lubwe deposit supported by further exploration at the Kababisa, Kamaranda and Kamisengo prospects. The construction is expected to start in 2025 and targeted for first production in 2028.

#### Project description:

|                                    |                                                                                                           |
|------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Stratiform, sediment-hosted copper deposit                                                                |
| NI 43-101 compliant Reserves       | 480 Mt @ 0.58 % Cu                                                                                        |
| Share of global copper reserves    | 0.3 % ( <i>USGS estimate global Cu reserves of 890 Mt</i> )                                               |
| NI 43-101 compliant resources      | 1920 Mt @ 0.52 % Cu                                                                                       |
| Share of global copper resources   | 0.5 % ( <i>USGS estimate global Cu reserves of 2,100 Mt</i> )                                             |
| Waste to ore ratio (whole orebody) | 2.73 (as of 2014)                                                                                         |
| Annual production                  | Pre-expansion: 25 Mt, containing 120 kt of Cu (in 2022)<br>Post-expansion: 50 Mt, containing 240 kt of Cu |
| Life of mine                       | Post-expansion: >30 years                                                                                 |
| Investment required                | US\$ 2bn (referring to expansion for 50 Mt of ore per year)                                               |
| Net present value (NPV)            | Not defined                                                                                               |
| Share of global copper production  | 1.1 % (240 kt of Cu/a, recovery 93 %)<br>( <i>USGS estimate global Cu production of 22 Mt</i> )           |
| Value addition potential           | All Lumwana’s copper concentrates are delivered to Zambian smelters.                                      |

#### Mining and processing:

- Conventional open pit methods employing drilling, blasting, shovelling and hauling in two open pits, namely Malundwe and Chimiwungo. The post-expansion mining plan envisages an ore production rate of 50 Mt/a with a relatively low average waste to ore ratio of 2.73 (as of 2014).

- The ore, which is predominantly sulphide, is crushed, milled and treated through a conventional sulphide flotation plant, producing copper concentrate (25-33 % Cu grades) for smelting. The copper recovery rate is ~93 %.
- The all-in sustaining costs in 2022 were reported at US\$ 8/kg of copper. This can be in line with the copper sales provisionally priced by Barrick until 31 December 2022, which were recorded at an average price of US\$ 8.38/kg (2021: US\$ 9.57/kg).

### **BGR assessment and comments:**

- The deposit is a low to intermediate-grade, high-tonnage operation with a relatively low waste to ore ratio of 2.73 (as of 2014). The relatively long life of mine (>30 years) is positive for the development of the region. Further resource expansions are possible due to the large exploration permit area Barrick owns and the stratiform character of the Copperbelt mineralisation.
- In 2022, Barrick's Lumwana project showed relatively high all-in sustaining costs of US\$ 8/kg of copper compared to a copper sales price of US\$ 8.38/kg. Even minor fluctuations on both the costs and the copper price side can lead to the project becoming unprofitable. Production costs will increase with time as the waste to ore ratio increases. With the US\$ 2bn investment in the Chimi Super Pit, Barrick aims to make Lumwana a Tier One project, which means, that long-term total cash costs will be in the lower half of the cost curve, currently ~US\$ 4/kg. A first step in reducing costs is the implementation of an owner-mining fleet in 2023 (Barrick estimated a cost-reduction by 20 %). To achieve further cost reductions, it is recommended to reassess the economic impact of by-products such as cobalt, gold and uranium.
- The Lumwana project is accessed via a 10 km road branching of the paved T5 two-lane highway connecting to the provincial capital of Solwezi (~65 km to the east). Currently, produced copper concentrates are trucked to smelters in the Zambian Copperbelt. Zambia aims to move 30 % of its cargo from road to rail and the construction of a 580 km rail line from Chingola through Lumwana and Solwezi to Kalumbila (phase 1) and from Kalumbila to the Angolan border (phase 2; connection to the Lobito Corridor) is planned. Costs for this project are estimated to ~US\$ 1bn and it is currently owned by Zambia's North-West Rail, in collaboration with Uroven, UK, and Transmashholding (TMH) subsidiary Smart Operations. Lumwana's power is sourced via the national grid delivered by the Zambia Electricity Supply Company (ZESCO). Water is sourced from pit dewatering and the Lumwana River.

### 4.11.3 ESG assessment

The planned expansion of the operation is still in an early planning phase, information on some ESG impacts of the expansion is still in a preliminary stage. However, assessment of the ongoing operation is indicating a diligent management and operational practice by Barrick, therefore conflict potential is generally assumed to be low.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Environmental management                                           | Project is ISO 14001 certified; companywide zero 'Class 1' environmental incidents for four years, and record low of two 'Class 2' incidents in 2022.                                                                                                                                                                                                                                                                                                                                     |
| Efficient use of energy, renewable energy, GHG emissions reporting | Current power supply from grid; Zambian grid has a high hydropower share (~78 %). Barrick is committed to net-zero by 2050, and reducing scope 1 and 2 emission until 2030 by 30 % from 2018 baseline. Established operations Scope 1 and 2 emissions 276,384 t CO <sub>2</sub> -eq in 2022; ~2.3 t CO <sub>2</sub> -eq per t copper, thus lower than the median of ~3.5 t CO <sub>2</sub> -eq for Cu projects worldwide (based on Skarn Associates Ltd. GHG Intensity data 2020).        |
| Water management and consumption                                   | Humid subtropical area with low water stress. The Lumwana project water supply is primarily sourced from local streams, and partially groundwater. Supply needs for expansion not clear at this planning stage. 83 % of water was reused in 2022. Barrick is applying the ICMM Water reporting framework companywide. Medium to high riverine flood risks.                                                                                                                                |
| Pollution prevention                                               | Geochemical tests indicating ore as not acid forming. Flotation technology may imply use of hazardous reagents.                                                                                                                                                                                                                                                                                                                                                                           |
| Air quality                                                        | Planned expansion of an existing mine, mine accommodation town might be impacted, other parts of assumed expansion area scarcely populated; no reports on conflicts, risk potential is assumed to be low.                                                                                                                                                                                                                                                                                 |
| Tailings management                                                | Current TSF with design capacity for 3 Mt; needs for expansion not clear at this planning stage. Barrick is working towards fully alignment with the Global Industry Standard on Tailings Management; working towards fully alignment for all high risk classified facilities.                                                                                                                                                                                                            |
| Waste management                                                   | Companywide policy for hazardous waste management in place; project is providing usable wastes to local business.                                                                                                                                                                                                                                                                                                                                                                         |
| Hazardous materials management                                     | Companywide policy for hazardous waste management in place.                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Noise and vibration                                                | Planned expansion of an existing mine, mine accommodation town might be impacted, other parts of assumed expansion area scarcely populated; no reports on conflicts, risk potential is assumed to be low.                                                                                                                                                                                                                                                                                 |
| Protected areas and biodiversity                                   | Companywide biodiversity policy and specific Biodiversity Action Plan for every project of Barrick in place. Project site not located in or close to any key biodiversity area, but inside the Acres forest reserve; the Lumwana project participates in the UN REDD+ project to reduce deforestation emissions; actions including community forest management and the implementation of alternative livelihoods. Barricks states the Pangolin as endangered species in the project area. |



| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mine closure                                              | Mine closure plan for current operations aims for progressive rehabilitation and is regularly updated (not reviewed for this assessment); any changes for the planned expansion are part of the upcoming feasibility studies (end of 2024).                                                                                                                                                                                                                                                                                                                                                          |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Community health, safety and security                     | Nearest settlements are the town of Manyama ~1 km south of the current operation at the T5 highway, and the Lumwana mining town in the east of the project area. The regional capital of Solwezi is the next major settlement ~65 km to the east. Although in close proximity, the apparent low conflict with the already established operation allows the assumption of a low conflict potential for the planned expansion.                                                                                                                                                                         |
| Dialogue and engagement with communities and stakeholders | A Community Development Committees is established at every of Barricks project. Barrick states the signing of a new Memorandum of Understand with local community chiefs on Barricks financial commitments in the communities; whether the planned expansion was already part of the negotiation was not clear. Barrick received 422 submissions through its grievance report mechanism in 2022 for all operations, 385 stated as resolved (companywide); 6 cases of grievance submitted specific for the Lumwana project, kind of grievances and quota of resolved cases not specified per project. |
| Land acquisition and involuntary resettlement             | Planned expansion of an existing mine risk potential is assumed to be low; expansion assumed to be restricted to the existing project site and the low populated northern area, mine accommodation town might be affected; final assessment dependable on the actual extent of the expansion.                                                                                                                                                                                                                                                                                                        |
| Occupational health & safety management                   | Project is ISO 45001 certified; lost time injury frequency rate <1.0, no fatalities since 2016.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Workers' rights                                           | Zambia scores 66.5/100 in the Labour Rights Index; no evidence of any shortcomings on the side of Barrick found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Gender and diversity                                      | Barrick is committed to several initiatives to increase diversity in the mining sector; no specific information for the Lumwana project available.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Local value added and community development               | The Lumwana Project currently employs ~1,800 people, 99 % are Zambian; increase in employment potential due to the expansion not clear at this stage. Business Accelerator Program aims to enable contractors to diversify their business beyond the Lumwana project. Further CSR measures including provision / funding of water supply and school buildings. In 2022 of US\$ 520m procurement expenditure US\$ 432m (83 %) were spent in Zambia; overall national economical contribution since 2011 ~US\$ 8.2bn.                                                                                  |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Legal compliance                                          | ESIA baseline monitoring for the expansion plan ongoing; scheduled with the completion of the feasibility study (end 2024).                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Management practices                                      | Barrick has a holistic set of management policies in place on company level; no evidence on any shortcomings found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |



| ESG category               | Assessment                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Transparency and reporting | Listed at NYSE and TSX; reports on financial accounts and shareholder structure available. Adopted reporting frameworks: UN Global Compact; World Gold Council's Responsible Gold Mining Principles; (ICMM) Mining Principles; Task Force for Climate-related Financial Disclosures.                                                                                                                               |
| Business ethics            | Zambia scores 37/100 in the Corruption Perception Index; Zambia is an EITI country; Human Rights company policy based on UN Guiding Principles on Business and Human Rights, the Voluntary Principles on Security and Human Rights and the OECD Guidelines for Multinational Enterprises; last independent human rights assessment for Lumwana in 2022. Anti-Bribery, Anti-Fraud, Whistleblower policies in place. |

Table 41. ESG features of Lumwana project, Zambia

#### 4.11.4 Further reading

Barrick Gold Corp. (2014): Technical Report on the Lumwana Mine, North-Western Province, Republic of Zambia. Report for NI 43-101. March 27, 2014.

[https://s25.q4cdn.com/322814910/files/doc\\_downloads/operations/lumwana/lumwana-03272014.pdf](https://s25.q4cdn.com/322814910/files/doc_downloads/operations/lumwana/lumwana-03272014.pdf) (accessed: 08.12.2023)

Barrick Gold Corp. (2023a): Zambia - Great future for Lumwana as Barrick unlocks potential...

[https://s25.q4cdn.com/322814910/files/doc\\_presentations/2023/Lumwana\\_Q2\\_2023\\_Media\\_Day.pdf](https://s25.q4cdn.com/322814910/files/doc_presentations/2023/Lumwana_Q2_2023_Media_Day.pdf) (accessed: 08.12.2023)

Barrick Gold Corp. (2023b): Local first policy drives Barrick's procurement practices.

[https://s25.q4cdn.com/322814910/files/doc\\_news/2023/06/Local\\_First\\_Policy\\_Drives\\_Barrick-s\\_Procurement\\_Practices.pdf](https://s25.q4cdn.com/322814910/files/doc_news/2023/06/Local_First_Policy_Drives_Barrick-s_Procurement_Practices.pdf) (accessed: 08.12.2023)

Barrick Gold Corp. (2023c): Barrick strengthens Zambia partnership, invests in major expansion of Lumwana mine.

[https://s25.q4cdn.com/322814910/files/doc\\_news/2023/10/Barrick\\_Strengthenes\\_Zambia\\_Partnership\\_Invests\\_in\\_Major\\_Expansion\\_of\\_Lumwana\\_Mine.pdf](https://s25.q4cdn.com/322814910/files/doc_news/2023/10/Barrick_Strengthenes_Zambia_Partnership_Invests_in_Major_Expansion_of_Lumwana_Mine.pdf) (accessed: 08.12.2023)

Barrick Gold Corp. (2023d): Results for Q3 2023 ...

[https://s25.q4cdn.com/322814910/files/doc\\_presentations/2023/Barrick\\_Q3\\_2023\\_Results\\_Presentation.pdf](https://s25.q4cdn.com/322814910/files/doc_presentations/2023/Barrick_Q3_2023_Results_Presentation.pdf) (accessed: 08.12.2023)

Barrick Gold Corp. (2023e): Barrick sustainability Report 2022 – Sustainable Delivery.

[https://s25.q4cdn.com/322814910/files/doc\\_downloads/sustainability/Barrick\\_Sustainability\\_Report\\_2022.pdf](https://s25.q4cdn.com/322814910/files/doc_downloads/sustainability/Barrick_Sustainability_Report_2022.pdf) (accessed: 16.12.2023)

## 4.12 Mahenge flake graphite project (Tanzania)

Information as of 09/2023

### 4.12.1 General project background

|                                    |                                                                                                                                                                                                                                                  |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Graphite                                                                                                                                                                                                                                         |
| <b>Location</b>                    | Morogoro, Tanzania<br>8°51' S, 36°43' E, 400 – 1300 m.a.s.l.                                                                                                                                                                                     |
| <b>License type</b>                | Special Mining License (35 km <sup>2</sup> ), valid until 12.12.2047                                                                                                                                                                             |
| <b>License owner / operator</b>    | Faru Graphite Corp. (84 % Black Rock Mining Ltd. (public company), 16 % Tanzania gov.)                                                                                                                                                           |
| <b>Contact</b>                     | 1 Walker Avenue, Level 1<br>West Perth, Western Australia 6005, Australia<br><a href="https://www.blackrockmining.com.au">https://www.blackrockmining.com.au</a><br><a href="mailto:info@blackrockmining.com.au">info@blackrockmining.com.au</a> |
| <b>Project status</b>              | Preproduction - Construction Planned                                                                                                                                                                                                             |
| <b>Possible production by 2030</b> | Announced for 2025; certain delay might be expected, but production by 2030 appears possible                                                                                                                                                     |

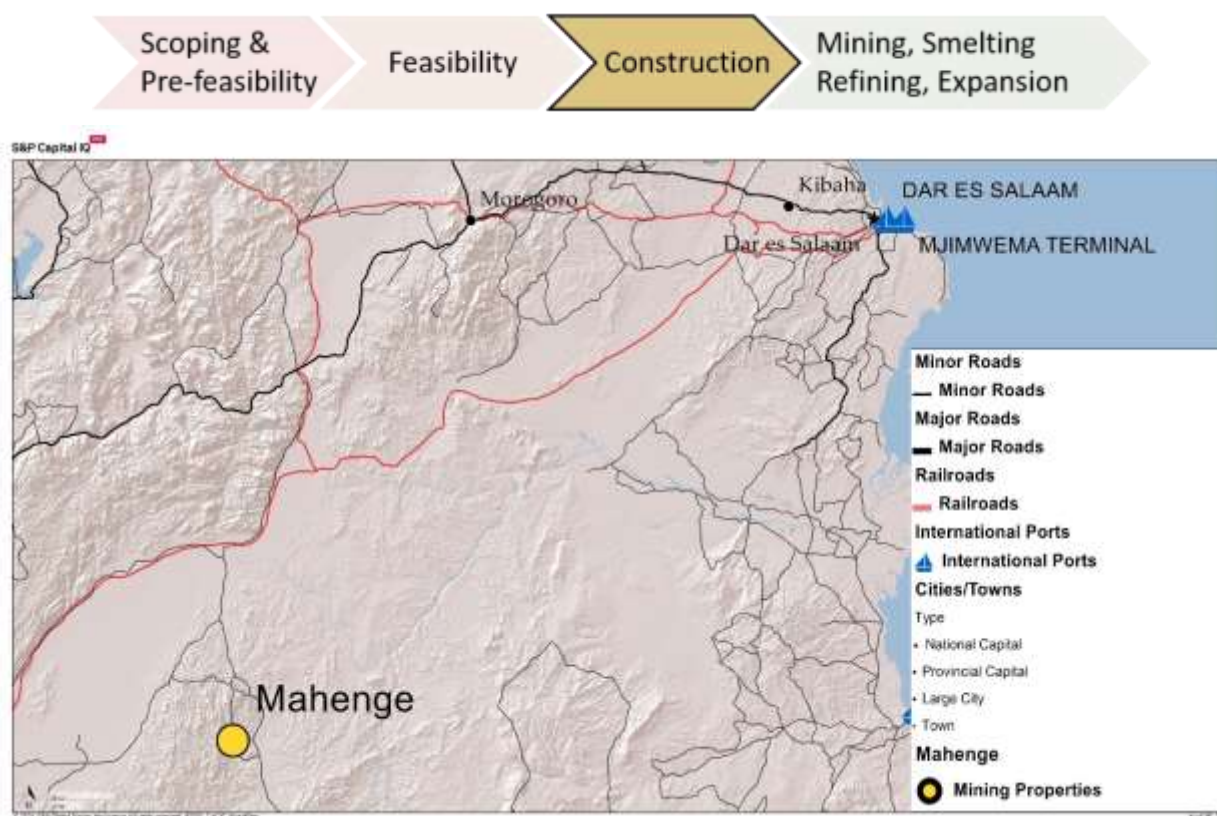


Figure 31. Mahenge project location, Tanzania

### 4.12.2 Economic assessment

#### General project background:

The Mahenge graphite deposit was first explored by Kibaran Resources in 2011 and is currently owned by Black Rock Mining. Graphite is hosted in graphitic gneisses of the Mahenge Scarp. These graphite-rich zones strike ~N-S with an extension of 22 km and dip 60-80° to the east. Black Rock plans to produce graphite concentrates that have a purity of 95-99 % total graphitic carbon (TGC). The project is to be implemented in four phases at the Ulanzi, Cascade and Epanko deposits. The staged construction is expected to reach maximum (Stage 4) annual production of 347 kt/a within four years of the start of Stage 1 (87 kt/a graphite concentrate). The owner is seeking investment for the Stage 1 (and subsequent stages) construction of the mine and processing plant, as well as on-site and off-site infrastructure.

#### Project description:

|                                                |                                                                                                                         |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                               | Flake graphite                                                                                                          |
| JORC compliant Reserves                        | 70.5 Mt @ 8.5 % TGC                                                                                                     |
| Share of global graphite reserves              | 2 % ( <i>USGS estimate global graphite reserves of 320 Mt</i> )                                                         |
| JORC compliant resources                       | 213.1 Mt @ 7.8 % TGC                                                                                                    |
| Share of global graphite resources             | 2 % ( <i>USGS estimate global graphite resources of 800 Mt</i> )                                                        |
| Waste to ore ratio (whole orebody)             | Expected to be low                                                                                                      |
| Annual production                              | 1 Mt of ore (stage 1), 89 kt of graphite concentrate<br>4 Mt of ore (stage 4), 347 kt of graphite concentrate           |
| Life of mine                                   | 26 years                                                                                                                |
| Investment required                            | US\$ 182m (Initial CAPEX for Stage 1 construction)                                                                      |
| Net present value (NPV)                        | US\$ 1.4bn (based on graphite basket price of US\$ 1,709/t, 10 % discount and 16 % free carry)                          |
| Share of global graphite production (Module 1) | 35 % (Stage 4; recovery 93 %)<br>( <i>USGS estimate global graphite production of 1 Mt</i> )                            |
| Value addition potential                       | Black Rock will construct a new road (Faru-John Road), thereby opening new areas suitable for resettlement and farming. |

#### Mining and processing:

- Conventional open pit methods employing drilling, blasting, and hauling over the Ulanzi, Cascade and Epanko deposits with possible free dig of highly weathered material. Mining commences at Ulanzi in year 0 followed by Cascade in year 2.
- The Module 1 processing plant will be fed ore at an average grade of 8.24 % TGC (recovery ~93 %) and produce ~87 kt/a of graphite products over the first 20 years. The ore is crushed in a three-stage crushing and screening plant. The milled ore slurry is going through several flotation and polishing circuits, afterwards to a flash dryer to reduce the concentrate moisture suitable for classification. The dry product is classified, and each product size (<100, >100, >80, >50, >32 µm) bagged separately for transport to customers. Mahenge's product profile is for 59 % >80 µm and 41 % <80 µm flakes and fines. Black Rock has considered additional

space for the construction of a future sulphide precipitation circuit when significant amounts of sulphide may be present in the fresh ore after ~10 years of production.

- The staged construction approach includes the stage 1 first Ulanzi and stage 2 second Ulanzi process plants and doubling the annual production from 87 kt to 174 kt within one year. In the subsequent two years, the Stage 3 first Cascade and Stage 4 second Cascade process plants will be constructed (347 kt annual production), the latter also treating ore from Black Rock's Epanko concession. The CAPEX for expansion is calculated to US\$ 107m, US\$ 117m and US\$ 104m for Stage 2, Stage 3 and Stage 4, respectively. The all-in sustaining costs for the first 10 years of US\$ 518/t of graphite concentrate compare to a calculated basket graphite concentrate price of US\$ 1,085/t.

#### **BGR assessment and comments:**

- Mahenge is a high-tonnage, high-grade and large flake-size graphite project. The relatively shallow position of the mineralisation should allow for low waste mining. The actual mine plan and reserve estimate does not include TGC grades below 3.8 %, which yields significant reserve upgrade potential and probable extension of the mine life.
- Black Rock assumed a high basket graphite price of US\$ 1,731/t FOB Dar es Salaam for its key financial assumptions. A more conservative price of US\$ 1,085/t is recommended, however, already considered by the company during recent presentations.
- The company has a major offtake agreement for its Module 1 fines with POSCO for an equity stake of 12 % in place. A further non-binding MoU with POSCO was signed concerning Module 2 offtake for an additional investment of US\$ 40m or an equity stake of 19.99 % (whichever is lower). Offtake agreements with two Chinese companies are in place comprising 33 % (30 kt) of annual Module 1 production for 3 years and options for additional 15 kt/a.
- Mahenge is located 480 km southwest of the capital Dar es Salaam. Graphite concentrates will be loaded into shipping containers and transported by road ~70 km to Ifakara, and then carried by rail ~350 km to the port of Dar es Salaam for export. The nearest town, Mahenge (population 8,000) is ~5 km to the east. Initial access to the project site will be via a ~4.5 km long, single lane, unsealed road, which will be upgraded by the project owner. Power supply (maximum demand of 45 MW in phase 4) is planned to initially be provided by diesel generators and from the TANESCO grid. For the grid connection (74 km plus substation), Black Rock is exploring financing options for the estimated cost of US\$ 33m outside the Mahenge project financing. Water supply is to be provided from surface water (nearby streams) as well as groundwater (bore field).

### 4.12.3 ESG assessment

The operational approach and corporate policies appear sufficient to enable compliant operation. No severe ESG risks were identified so far. However, evidence of good practice in different management areas is so far not available. Lacking information on mine closure measures and apparently missing capital allowances so far, is a point to be clarified by potential investors.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Environmental management                                           | ISO 14001 certification; no reports on any incidents found.                                                                                                                                                                                                                                                                                                                                                                                              |
| Efficient use of energy, renewable energy, GHG emissions reporting | Power supply from national grid, currently 39 % hydropower; company expects increasing hydropower share; nearby Julius Nyerere Hydro project is expected to start production 2024. The project is committed to provide infrastructure base for the development of renewable energy projects in the region. Total installed load of the project approximately 45.2 MW, maximum demand of approximately 33.2 MW and average load of approximately 31.5 MW. |
| Water management and consumption                                   | Humid area (1,650 mm precipitation), with low water stress; dry season from May to October; water storage dam supplied from rainfall, additional sourcing from streams and groundwater possible. Riverine flood risk extremely high; stormwater management designed for 1000-year event.                                                                                                                                                                 |
| Pollution prevention                                               | Black Rock states that AMD potential will be low in the first 10 years of operations due to low sulphide content, processing will then be upgraded by an additional sulphide circuit; AMD potential unclear. Flotation technology may imply use of hazardous reagents.                                                                                                                                                                                   |
| Air quality                                                        | Conventional drilling and blasting mining and tailings disposal requires dust suppression measures, with regard to the proximity of 2 km to the resettlement village. Transport of product in shipping containers will reduce dust emission.                                                                                                                                                                                                             |
| Tailings management                                                | Tailing dry stacking planned to reduce TSF footprint, increase stability and enhance circular water management; design in accordance with Tanzanian Water Resources Management regulations, Australian National Committee on Large Dams Guidelines (2012; ANCOLD guideline had been upgraded 2019 in the same year as Mahenge DFS).                                                                                                                      |
| Waste management                                                   | Mine waste will be initially used for infrastructure (e.g. road construction), and afterwards landfilled. Hazardous and recyclable wastes will be send to external service provider.                                                                                                                                                                                                                                                                     |
| Hazardous materials management                                     | Flotation and use of required reagents is considered low risk assuming responsible handling; no information on specific used reagents available.                                                                                                                                                                                                                                                                                                         |
| Noise and vibration                                                | Conventional drilling and blasting mining requires mitigation measures (e.g. low-impact sequential blasting), with regard to the proximity of 2 km to the resettlement village.                                                                                                                                                                                                                                                                          |
| Protected areas and biodiversity                                   | Several small forest reserves and key biodiversity areas (predominately vulnerable plant species) are located in the region. Black Rock states 80 %                                                                                                                                                                                                                                                                                                      |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | of the actual project area had been cleared for farming (with currently 15 % actively farmed) moderate number of native fauna. Riverine forests had been identified as important vegetation type with high species diversity.                                                                                                                                                                                                                                                                                                                                         |
| Mine closure                                              | Progressive closure is planned, but no detailed information on mine closure planning were available. No end of LOM rehabilitation costs or mine closure costs have been assumed.                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Community health, safety and security                     | Project area sparsely settled and dominated by subsistence agriculture, forestry and artisanal mining are minor income sources. Mahenge township is the nearest major settlement (population of the Mahenge district around 10,000) about 9 km southeast from the project area, in case of Mahenge the distance appears large enough that the potential negative impact on the local population is generally considered low risk. Smaller settlements in the project area have to be resettled; a resettlement village will be constructed 2 km north of the project. |
| Dialogue and engagement with communities and stakeholders | Black Rock states constructive stakeholder communication from their side, clear evidence of good practice is missing.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Land acquisition and involuntary resettlement             | Resettlement Action Plan negotiations, land acquisition and first compensation payments commenced, total costs estimated at A\$ 11.5m. Construction of a resettlement village for around 300 families planned.                                                                                                                                                                                                                                                                                                                                                        |
| Occupational health & safety management                   | ISO 45001 certification; OHS policy based on Australian and Tanzanian safety standards.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Workers' rights                                           | Tanzania scores 74/100 in the Labour Rights Index. Black Rock reports of traditional ASM in the region (gemstones and marble), no information on engagement available, but also no indication of deficiencies/conflicts found.                                                                                                                                                                                                                                                                                                                                        |
| Gender and diversity                                      | Diversity and inclusion policy available; Black Rock seeks to align with the ASX principles and recommendations in this regard.                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Local value added and community development               | Black Rock estimates 905 employees for operational phase; committed to employ locally where qualified workforce is available and implement training programs to develop local employees to take over roles in the long term. Project is stated as opportunity to improve overall reliability of local power supply. Royalties are set at 3.0%.                                                                                                                                                                                                                        |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Legal compliance                                          | Environmental licence granted in 2018 (EC/EIA/2018/0352); Update of ESIA in 10/2022.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Management practices                                      | ISO 9001 certification. Relevant policies available (e.g. risk management, performance evaluation, trading policies, shareholder communication). No indication of poor management practices so far.                                                                                                                                                                                                                                                                                                                                                                   |



| ESG category               | Assessment                                                                                                                                                                                    |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Transparency and reporting | Listed on ASX; information for investors, information on financial accounts and shareholder structure available. Adopted reporting frameworks: IFC performance standards, Equator principles. |
| Business ethics            | Tanzania scores 40/100 in the corruption perception index; Tanzania is an EITI country; anti-bribery & corruption policy, whistleblower policy, and code of conduct in place.                 |

Table 42. ESG features of Mahenge project, Tanzania

#### 4.12.4 Further reading

Black Rock Mining Ltd. (2022) Black Rock Completes Front End Engineering Design, Reconfirming Mahenge as Tier 1 scale project with compelling projected returns. <https://blackrockmining.com.au/wp-content/uploads/BlackRockCompletesFEEDAndDFSUpdate.pdf> (accessed: 22.09.2023)

Black Rock Mining Ltd. (2023a) Black Rock signs MOU with POSCO for Mahenge Module 2 offtake for BKT investment of up to US\$40m. <https://blackrockmining.com.au/wp-content/uploads/BlackRockSignsMOUWithPOSCOForMahengeModuleTwoOfftakeForBKTInvestmentOfUpToUSFortyMillionDollars04Sep23.pdf> (accessed: 22.09.2023)

Black Rock Mining Ltd. (2023b) Mahenge Graphite Mine – Simply Better Graphite: Investor Update. <https://blackrockmining.com.au/wp-content/uploads/ShawAndPartnersGraphiteConferenceInvestorPresentation20Jun23.pdf> (accessed: 22.09.2023)



## 4.13 Makuutu ion adsorption-type REE (-Sc) project (Uganda)

Information as of 01/2024

### 4.13.1 General project background

|                                    |                                                                                                                                                                                                                 |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | REE (mixed rare earth carbonate product)                                                                                                                                                                        |
| <b>Other commodities</b>           | Scandium                                                                                                                                                                                                        |
| <b>Location</b>                    | Iganga, Bugweri, Mayuge and Bugiri districts, Uganda<br>0°31' N, 33°34' E, 1130 – 1180 m.a.s.l.                                                                                                                 |
| <b>License type</b>                | LSM licence granted in 01/2024 (43.78 km <sup>2</sup> )                                                                                                                                                         |
| <b>License owner / operator</b>    | 60 % ownership by Ionic Rare Earths Ltd. (public company) through Rwenzori Metals Ltd., expansion to 94 % underway (12/2023)                                                                                    |
| <b>Contact</b>                     | 459 Collins Street, Level 5, South Melbourne, Victoria 3000, Australia<br><a href="https://www.ionicre.com.au">https://www.ionicre.com.au</a><br><a href="mailto:admin@ionicre.com.au">admin@ionicre.com.au</a> |
| <b>Project status</b>              | Active, Feasibility completed                                                                                                                                                                                   |
| <b>Possible production by 2030</b> | Announced for 2024; certain delay might be expected, but production by 2030 appears possible                                                                                                                    |



Figure 32. Makuutu project location, Uganda

### 4.13.2 Economic assessment

#### General project background:

The ~37 km long Makuutu trend hosts numerous REE mineralisation of the ion-adsorption clay-type. Airborne surveys in 1980 identified uranium anomalies in the project area. The REE potential was first discovered in 2011. The deposit is characterised by high tonnage and low grades. The mineralisation is interpreted to be in a flat lying weathered profile including cover soil, lateritic caprock, clays transitioning to saprolite and saprock. The saprock is underlain by fresh shales, siltstones and mudstones. The REE-bearing ore is hosted within generally horizontal, 10 to 20 m thick regolith, which makes it easily accessible. The owner seeks investment for the Stage 1 production of a value-added product, mixed rare earth carbonate (MREC) (including Scandium ~511 t), via a modular heap desorption processing plant. The company expects the final investment decision in H2/2024 and first MREC production is targeted for Q4/2024.

#### Project description:

|                                    |                                                                                                                                                                                                                                                     |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Ion-adsorption clay-type (IAC) REE deposit                                                                                                                                                                                                          |
| JORC compliant reserves            | 172.9 Mt @ 848 g/t TREO, 30 ppm $\text{Sc}_2\text{O}_3$                                                                                                                                                                                             |
| Share of global REO reserves       | 0.1 % ( <i>USGS estimate global REO reserves of 120 Mt</i> )                                                                                                                                                                                        |
| JORC compliant resources           | 358 Mt @ 538 ppm TREO ( <i>BGR calculation based on DFS data</i> )                                                                                                                                                                                  |
| Waste to ore ratio (whole orebody) | 0.57 for 172.9 Mt                                                                                                                                                                                                                                   |
| Annual production                  | 5 Mt of ore (Stage 1), 1,160 t contained REO                                                                                                                                                                                                        |
| Life of mine                       | 35 years                                                                                                                                                                                                                                            |
| Investment required                | US\$ 121m (for Stage 1 for mine and processing plant)                                                                                                                                                                                               |
| Pre-tax net present value (NPV)    | US\$ 406m assuming 8 % discount rate, based on long term TREO basket (excl. $\text{Sc}_2\text{O}_3$ ) and $\text{Sc}_2\text{O}_3$ prices of US\$ 120.81/kg and US\$ 775/kg, respectively; metallurgical recovery of 75 % as well as OPEX and CAPEX. |
| Share of global REO production     | 0.4 % (recovery 75 %)<br>( <i>USGS estimate global REO production of 280,000 t</i> )                                                                                                                                                                |
| Value addition potential           | Purchase of sulphuric acid from an existing sulphuric acid producer on the Kenyan-Ugandan border.                                                                                                                                                   |

#### Mining and processing:

- Conventional open pit methods employing free dig of the near surface mineralisation using truck and shovel. Mining will be conducted (as previously defined as reserve) in 4 zones, namely the central, the central east, the C and F zones and involve a pre-strip of 1 m of topsoil, which will be stockpiled adjacent to the pit. A marginal cut-off grade of 200 ppm TREO (excluding  $\text{CeO}_2$ ) will be applied. Plant feed grades will initially be ~900 ppm REO relaxing to grades as low as ~700 ppm towards the end of the mine life with an average annual production of 5 Mt of ore.
- Mineral processing will include heap leach desorption of the clay by chemical washing of the ore with a salt-based solution, using ammonium sulphate ( $\text{NH}_4\text{SO}_4$ ), at mild acidic conditions, using sulphuric acid ( $\text{H}_2\text{SO}_4$ ) at an approximate pH of 2. Membrane solution purification will be

applied followed by staged carbonate precipitation. The extracted product represents a value added intermediate chemical precipitate known as MREC product. Metallurgical recoveries of up to 75 % TREO minus Cerium are reported by the company.

- The MREC contains ~71 % magnet and heavy REO content (Nd, Pr, Dy and Tb; ~31 %) and is free of radionuclides, suitable for export for further processing via solvent extraction refining to high purity oxides. IonicRE applied Adamas Intelligence REO price forecasts to the individual Makuutu basket, resulting in basket price values ranging between US\$ 109.41/kg REO and US\$ 138.53/kg REO for the years 2025 to 2035.
- The operating expenditures are given at US\$ 52.99/kg REO including US\$ 6.86/kg REO  $\text{Sc}_2\text{O}_3$  credit as well as US\$ 14.31/kg and US\$ 13.78/kg REO costs for mining and processing & environment, respectively. IonicRE assumes a revenue of US\$ 120.81/kg REO (excl.  $\text{Sc}_2\text{O}_3$ ). Assuming a maximum production of 25,000 kg/a of  $\text{Sc}_2\text{O}_3$  (99.9 % purity), the revenue would increase to US\$ 134.61/kg of product (based on a  $\text{Sc}_2\text{O}_3$  price of US\$ 775/kg).

#### **BGR assessment and comments:**

- The deposit is a low-grade, high-tonnage operation with a low waste to ore ratio of 0.57. The long life of mine (35 years) can be positive for the development of the region. Resource expansions are possible due to the 37 km long mineralisation trend, which has not yet been investigated at a whole for REEs.
- Several groups have indicated strong interest in working with IonicRE to bring the Makuutu REO basket into key western markets across the US, EU and UK, however the maturity of the downstream supply chain still requires significant investment, limiting the capacity for Makuutu to scale up at this time.
- Makuutu's high proportion of valuable magnet-related REEs indicate the generation of ~83 % of its REE revenues from just 31% of its production volume (NdPr, Dy and Tb oxides). IonicRE's revenue and NPV are based on long term REO basket of US\$ 120.81/kg and  $\text{Sc}_2\text{O}_3$  prices of US\$ 775/kg. No impurity penalties have been applied. The company assumes all elements contained in the MREC (e.g., 99.9 % purity  $\text{Sc}_2\text{O}_3$ ) attract the highest prices in the market.

### 4.13.3 ESG assessment

The project site is located in an intensively used agricultural area with a high population density. It is located in a water catchment area that discharges into Lake Kyoga that is part of the river Nile system. Thus major issues are relocation and compensation management in the forefront of the mining activity as well as water management and avoiding negative impacts on water resources. Potential NORM (Naturally occurring radioactive material) risk. Technically, the process water management poses a challenge to the environment since the high average precipitation of about 1500 mm/a on the leach pads could disturb leaching conditions and result in seepage to the environment. The ESG rating of the company by the commercial disclosure website Digbee is BB. However public information on ratings, performance or ESIA could not be found on internet/websites. According to the project owner IonicRE, the company will include, details on water management in the project implementation plans. Makuuto is presently the only asset of the ionic rare earths company. With regard to the ESG risks of the Makuuto project, only a general assessment is meaningful.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Environmental management                                           | There is no track record of incidents, the company claims commitment to the UN Sustainable Development Goals. No information about existing or planned environmental management at Makuutu.<br>The project company has achieved the approval of the Environmental and Social Impact Assessment ESIA by the concerning National Environmental Management Authority NEMA in 2022.                                                                                                                                                                                                    |
| Efficient use of energy, renewable energy, GHG emissions reporting | There are four hydroelectric power plants located within 65 km of the project area, with total installed generating capacity of approximately 810 MW, providing electricity from the grid with a low CO <sub>2</sub> -intense power to the project. Planned nano-filtration process would require a bigger power supply that could be generated by renewable energy. No company information on planned scope 1 and scope 2 emissions available. Electricity in Uganda is mainly produced by Hydropower (92 %) and biofuel (7 %). Share of electricity from photovoltaic is rising. |
| Water management and consumption                                   | Water will be sourced from the Makuutu site, given the project location in a region with low water stress and high rainfall (around 3,000 mm/a). A net positive process water balance will require membrane processes to be used to manage site discharge water for reagents recovery. Excess water management will be a key focus of the project to ensure environmental standards are met and reagent consumption is minimised.                                                                                                                                                  |
| Pollution prevention                                               | No project information available. No AMD potential because of lateritic soil profile. However the deposit has a potential to produce a NORM risk, since uranium and thorium would be dissolved in the leaching process and concentrated in the resulting waste precipitate. No information available about waste management.                                                                                                                                                                                                                                                       |

| ESG category                     | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Air quality                      | Expected emissions from mining and processes are low. The population density with about 250 persons per km <sup>2</sup> in the mining area is quite high. This would require management measures to ensure an adequate air quality.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Tailings management              | Post processing, the residue is washed to recover residual reagents and process liquors. Afterwards it is neutralised. Prior to reclamation the residues are neutralized and redeposited in the mining pit voids. Then rehabilitation of the mined areas is carried out. There is no information available about an assessment of the NORM-risks in the tailings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Waste management                 | Because of the low waste to ore ratio the amount of mining waste is relatively small and the waste can be filled in the mining voids. Additionally the leaching residues will be transported back to mined out areas and used as backfill. Because of the swelling of waste and leached out ore an increase in the level of the terrain can be expected after mining. Deleterious elements for the Makuutu Project are present in the form of semi-soluble gangue minerals that cannot be easily separated, or constitute the minerals of interest. These deleterious elements include aluminium, calcium, iron, silicon, thorium, uranium, and zinc, all of which are present in the pregnant leach solution to some extent. These deleterious ions in the leach solution are rejected and precipitated using membrane solution purification. The precipitate will be dewatered using chamber filter presses. There is no information available about the whereabouts of the elements uranium and thorium in the process. |
| Hazardous materials management   | In the processing facility a salt-based solution, using ammonium sulfate (NH <sub>4</sub> SO <sub>4</sub> ), at mild acidic conditions, using sulfuric acid (H <sub>2</sub> SO <sub>4</sub> ) at an approximate pH of 2 is used to leach the ore. The moderate acidic conditions help to reduce the dissolution of Al and Fe, and thereby reducing the reagent consumption required to precipitate undesired elements. There is no further information available about company measures with regard to hazardous material management.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Noise and vibration              | No information available about company management measures. The population density with about 250 persons per km <sup>2</sup> in the mining area is quite high. This would require management measures to ensure an adequate noise and vibration level in order to protect communities.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Protected areas and biodiversity | In the project area there are no key biodiversity areas or protected areas listed. The closest key biodiversity areas are the Thruston Bay granite hills located in a distance of abt. 20 km south-west of the project area and the Kibimba Rice Scheme in 5 km distance north of the project area. Inside of the concession there are several areas categorized as protected forests but it is unknown whether the mining activities will have direct impacts on these zones. However, indirect impacts because of infrastructure development and settlement could be expected.                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Mine closure                     | Mining will involve a pre-strip of 1m of topsoil, which will be stockpiled adjacent to the pit. Mining will be selective with lower grade ore stockpiled adjacent to the pit, whilst waste will be mined and paddock dumped either adjacent to or if possible inside the pit. Once areas are                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | <p>completely mined out, the mined waste and heap leach residue will be reclaimed and the slot will be backfilled (progressive rehabilitation), prior to the topsoil spread back on the area disturbed.</p> <p>Subsequent new organised agri-industry will be established to align with Uganda's National Development Plan, NDP-III. As such there will be no tailings facility or permanent waste heaps planned.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Community health, safety and security                     | A workforce of semi-skilled and artisanal workers would be available from nearby towns and villages. The closest major settlement is Iganga, which has a population of 50,000. The town of Mayuge is located approximately 10 km from the project site. Issues for community health, safety and security are not known so far.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Dialogue and engagement with communities and stakeholders | As part of the ESIA there was a structured dialog, in which about 3.800 persons participated. However, there is no indication that the engagement with communities and stakeholders continues.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Land acquisition and involuntary resettlement             | Before mining operations can begin, IonicRE is committed to compensate landowners and resolve the remaining land access agreements. A process of stakeholder identification and engagement is in advanced stages of concluding the Resettlement Action Plan RAP development process. This process involves engaging directly affected Project Affected Persons PAPs, key village, sub county and district stakeholders throughout the three districts of Bugweri, Mayuge and Bugiri, plus national stakeholders. The Project will undertake a due diligence process of confirming the areas mapped as well as entering into MoU's with PAPs to support land access. Over 95% of land access agreements have been secured for the Makuutu Stage 1 Mining Licence Application (12/2023) and is working to resolve the remaining 5%. There is no world heritage site close to the project. |
| Occupational health & safety management                   | No information available because of the early project stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Workers' rights                                           | There are no ASM activities on the project area. No further information available. According to the labour right index in Uganda there is only limited access to decent work.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Gender and diversity                                      | The company has adopted a diversity policy, which applies to all directors and employees of the company, and sets out the company's commitment to managing diversity.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Local value added and community development               | The intent of the project is to source staff for the operations from the local communities and train staff accordingly. No fly in – fly out is envisaged, and the number of expatriate staff is intended to be low, and to be phased out over time. Industrial facilities are available in the city of Jinja, approximately 40 km from the project area. Additional industrial facilities are available on the outskirts of Kampala. Since 2020 Uganda is admitted as an EITI implementing country. Rwenzori Rare Metals has paid in 2020 taxes and fees to the Ugandan government that amount to UGS 32,869,722. The company claims that it contributed to communities                                                                                                                                                                                                                 |



| ESG category               | Assessment                                                                                                                                                                                                                                                                                                            |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | by the installation of drinking water wells. Local value added shall be achieved by using mainly local workforce.                                                                                                                                                                                                     |
| <b>Governance</b>          |                                                                                                                                                                                                                                                                                                                       |
| Legal compliance           | Environmental permits approved according to company statement; Stage 1 Mining Licence 00334 received January 2024                                                                                                                                                                                                     |
| Management practices       | Information on policies and management of ESG issues not available<br>Digbee ESG certified (BB level) (Jan 2024); IonicRE joined the United Nations Global Compact sustainability initiative                                                                                                                          |
| Transparency and reporting | The project owner “Ionic Rare Earths” is listed on the ASX. No sustainability reporting is available. However, financial reporting is available on the website. The headquarter is in Melbourne, Australia.                                                                                                           |
| Business ethics            | Location not in a conflict-affected and high-risk area (CAHRA); the country corruption index is 26/100 and the rank of Uganda is 141/180; no track record of incidents; no information about supply chain due diligence policies; however, the company plans a vertical integrated production of rare earth products. |

**Table 43. ESG features of Makuutu project, Uganda**

#### 4.13.4 Infrastructure assessment

##### Potential Investment Needs:

- **Railway Enhancements:** Investment opportunities exist in the development of railways to potential new inland port facilities.
- **Water Supply:** Investment opportunities in provision of water collection and reticulation; water treatment, sewage treatment and disposal.
- **Port Storage Facilities:** Investment opportunities to develop and improve own inland port facilities.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | Makuutu comprises six licences covering approximately 298 km <sup>2</sup> and is located approximately 40 km east of the regional centre of Jinja and 120 km east of the capital city of Kampala in eastern Uganda. Makuutu is surrounded by tier-one infrastructure with tarred roads, nearby rail, power and water, cell-phone coverage, as well as being readily accessible throughout the year irrespective of weather conditions. Industrial facilities are available in the city of Jinja. Additional industrial facilities are available on the outskirts of Kampala. |
| Transport                 | The Makuutu site is approximately 10 km from the A109 Highway, which is a sealed bitumen road (i.e., paved road) connecting to Kampala, Kenya, and to the Port of Mombasa. All weather access roads connecting the site to the adjacent highway already exist.                                                                                                                                                                                                                                                                                                               |



|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Airport      | There are four surrounding airports in Uganda namely: Namulonge Airport & Kajjansi Airfield (140 km), Entebbe International Airport (170 km) and Tororo Airfield (90 km).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Rail access  | A rail line lies 10 km north of the Makuutu site near the town of Iganga that leads to Kampala via Jinja in the west and the port of Mombasa to the east. Current rail infrastructure is capable of transporting material for commercial purposes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Port         | Uganda has two inland ports and several defunct and underdeveloped harbours. It is depended on port-facilities in neighbouring countries like Kenya and Tanzania. The Ugandan government has undertaken measures to develop their own port facilities and terminals by planning a second route to the Indian Ocean, via Bukasa dry port and Musoma, and linked by railways to Tanga. However, inadequate financial investments have halted the planning and development of these projects. Nevertheless, Uganda plans to renegotiate a financing deal with lenders of Bukasa inland port on Lake Victoria, to save the US\$ 229m project, which has stalled at the dredging, swamp removal, and reclamation stage. |
| Energy       | There are four hydroelectric power plants located within 65 km of the project area, with total installed generating capacity of approximately 810 MW, providing an abundant supply of cheap power to the project. The site is serviced by existing 132 kV electrical infrastructure, with the main power corridor running immediately north of the current project area and immediately adjacent to the proposed process plant location.                                                                                                                                                                                                                                                                           |
| GHG emission | As the major energy supply originates from hydroelectric power plants, the carbon emissions are expected to be low. Carbon emissions during operation needs further investigation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Water        | Water will be sourced at the project by harvesting rainwater from the Makuutu site, given the project location in a positive rainfall environment, and a net positive process water balance will require membrane processes to be used to manage site discharge water for reagent recovery.                                                                                                                                                                                                                                                                                                                                                                                                                        |

**Table 44. Infrastructure assessment of Makuutu project, Uganda**

#### 4.13.5 Further reading

Ionic Rare Earths (2021) Ionicre signs MOU with Chinalco for potential investment, offtake and mine development. <https://ionicre.com.au/wp-content/uploads/post/210407i.pdf> (accessed: 21.08.2023)

Ionic Rare Earths (2022): Annual Report 2022. <https://wcsecure.weblink.com.au/pdf/IXR/02580865.pdf> (assessed 04.12.2023)

Ionic Rare Earths (2023a) Ionicre moves to 60 % ownership of Makuutu rare earths project. <https://wcsecure.weblink.com.au/pdf/IXR/02653808.pdf> (accessed: 21.08.2023)

Ionic Rare Earths (2023b) Makuutu Stage 1 DFS confirms technical and financial viability for sustainable, long-life supply of magnet and heavy rare earths, maiden ore reserve estimate. <https://wcsecure.weblink.com.au/pdf/IXR/02645488.pdf> (accessed: 21.08.2023)

## 4.14 Maniry metasedimentary graphite project (Madagascar)

Information as of 11/2023

### 4.14.1 General project background

|                                    |                                                                                                                                                                                                                  |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Graphite                                                                                                                                                                                                         |
| <b>Location</b>                    | Toliara, Madagascar<br>24°31' S, 44°51' E, 250 – 300 m.a.s.l.                                                                                                                                                    |
| <b>License type</b>                | Mining license PE5394 (20 km <sup>2</sup> )<br>Exploration licenses (total of 125 km <sup>2</sup> )                                                                                                              |
| <b>License owner / operator</b>    | Evion Group NL (public company)                                                                                                                                                                                  |
| <b>Contact</b>                     | 1138 Hay Street, Level 3<br>West Perth, Western Australia 6005, Australia<br><a href="https://www.eviongroup.com">https://www.eviongroup.com</a><br><a href="mailto:info@eviongroup.com">info@eviongroup.com</a> |
| <b>Project status</b>              | Feasibility complete                                                                                                                                                                                             |
| <b>Possible production by 2030</b> | Announced for 2024; certain delay might be expected, but production by 2030 appears possible                                                                                                                     |

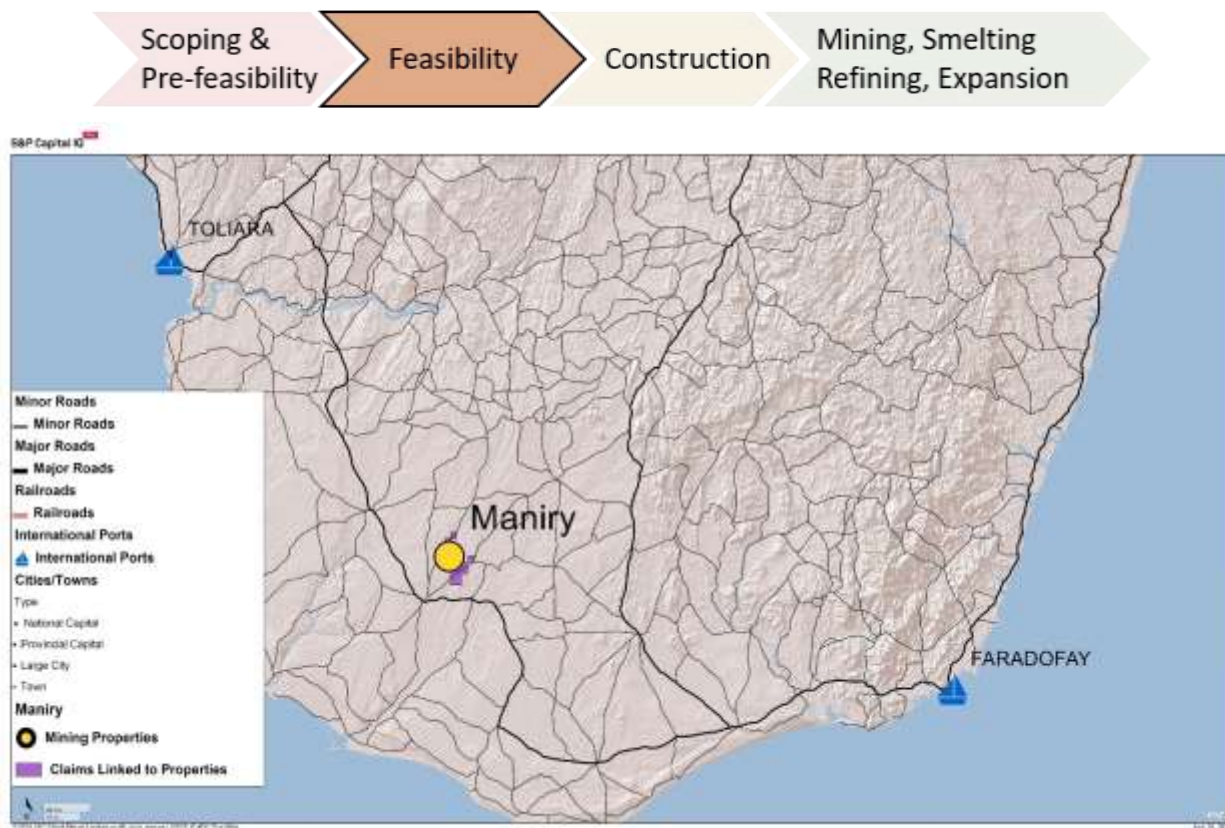


Figure 33. Maniry project location, Madagascar

### 4.14.2 Economic assessment

#### General project background:

Madagascar has a 100-years graphite mining history. Among these graphite projects, the Maniry deposits (Razafy and Razafy NorthWest) show intermediate tonnages, but high grades. The deposits are situated within metasediments (graphite schist, marble, quartzite, amphibolites and leucogneiss) of the Graphite Sequence, just southwest of the Saririaky anorthosite massif. Two extensive N-S trending ductile shear zones have been mapped up to 250 km long and tens of km wide, namely the Ampanihy shear zone and the Vorokafotra shear zone. Disseminated graphite flakes occur in two main layers between about 20 and 40 m and hosted within granulitic gneisses. The mineralised zones strike NNW and dip at  $\sim 45\text{--}75^\circ$  to the ENE and have been traced  $\sim 1,300$  m strike length. The owner seeks investment for mine, processing plant and infrastructure. After completion of the Feasibility Study, the project is now progressing into construction and operations with commissioning targeted in 2024.

#### Project description:

|                                                  |                                                                                                                                             |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                                 | Flake graphite                                                                                                                              |
| JORC compliant Reserves                          | 16.2 Mt @ 6.6 % TGC                                                                                                                         |
| Share of global graphite reserves                | 0.3 % ( <i>USGS estimate global graphite reserves of 320 Mt</i> )                                                                           |
| JORC compliant resources                         | 40 Mt @ 6.5 % TGC                                                                                                                           |
| Share of global graphite resources               | 0.3 % ( <i>USGS estimate global graphite resources of 800 Mt</i> )                                                                          |
| Waste to ore ratio (whole orebody)               | 2.1                                                                                                                                         |
| Annual production                                | 0.5 Mt of ore (stage 1), 39 kt graphite concentrate<br>1 Mt of ore (stage 2), 56.4 kt graphite concentrate                                  |
| Life of mine                                     | 21 years                                                                                                                                    |
| Investment required                              | US\$ 105m (for stage 1 and stage 2 mine and processing plant)                                                                               |
| Net present value (NPV)<br>(post-tax)            | US\$ 205m (based on a graphite concentrate price of US\$ 1,300, a royalty of 2 % and a discount of 8 %)                                     |
| Share of global graphite production<br>(stage 2) | 6.5 % (1 Mt of ore per year, recovery 90 %)<br>( <i>USGS estimate global Sn production of 310,000 t</i> )                                   |
| Value addition potential                         | In partnership with Urbix (USA), Evion plans to build a Battery Anode Material Plant in Germany to be fed with Maniry graphite concentrate. |

#### Mining and processing:

- Conventional open pit methods employing drilling and blasting followed by loading and hauling in the two main deposits Razafy and Razafy Northwest. The stage 1 (first three years) mining plan envisages an ore production rate of 0.5 Mt/a with a relatively low average waste to ore ratio of 2.1 increasing to an annual production of 1 Mt from year four (stage 2).
- Processing comprises crushing, grinding and flotation. A product grade of 95 % TGC (average) at 90 % recovery will be filtered, dried, screened and bagged ready for transport to

market. The main outcomes from the 60 t pilot operation were a product size distribution of 1.5 % >500 µm, 11 % >300 µm, 26 % >180 µm, 13 % >150 µm and 48.5 % <150 µm.

- The operating expenditures are given at US\$ 658/t FOB of graphite concentrate facing a sales price of US\$ 1,448/t graphite concentrate.
- In partnership with Urbix (USA), Evion plans to build a Battery Anode Material Plant in Germany, which will require some 30,000 t/a of Maniry graphite concentrate. Furthermore, Evion develops its Expandable Graphite joint venture in India, which is planned to be fed by 4,000 t/a of Maniry graphite concentrate.

#### **BGR assessment and comments:**

- Maniry is a high-grade, intermediate-tonnage and medium flake-size graphite project. The relatively long life of mine (20 years) can be positive for the development of the region. The relatively shallow position of the mineralisation should allow for low waste mining (stripping ratio of 2.1 envisaged). The actual mine plan as well as reserves and resources estimates do not include TGC grades below 3 %. Furthermore, mineralised zones can be traced along ~1,300 m strike, are open at depth and thus yield exploration potential. Altogether, mine life extension by several years due to significant reserves and resources upgrades are likely as Evion's exploration targets 260-380 Mt at 6-8 %TGC.
- Maniry is located in the southwest of Madagascar, ~180 km south-east of Toliara, the capital of the region and the port the company plans to transport (via road) the bagged product to. Access to the project from Toliara is via paved road for 70 km only and subsequent secondary all-season roads (RN10) for a distance of 200 km, which may be restricted during rainy season. Both the port of Toliara as well as the full length of the RN10, have recently been agreed to be significantly upgraded involving the European Union, World Bank and the Government of Madagascar. Upgrades are not included in the Feasibility Study and may be potentially very significant to the operating expenditures. Raw water is planned to be supplied via a raw water borefield and will utilise a planned pipeline system. Power is planned to be supplied on-site via a Build Own Operate solar (battery)/diesel hybrid facility. Evion plans 98 % of the staff at the Maniry project to be Malagasy (>400 personnel).

#### **4.14.3 ESG assessment**

Due to the early stage of the project detailed information on several management and ESG aspects are not yet available. No major ESG issues were identified so far, which could not be handled by diligent management and operational practice. Reports on opposition to necessary resettlements indicating a conflict potential, particular attention is recommended here.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Environmental management                                           | No reports on incidents found. No information on environmental management issues available.                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Efficient use of energy, renewable energy, GHG emissions reporting | For power supply a combination of photovoltaic-battery plant and diesel generator is planned to build; 35 % of the 32 MWh/a power need will be initially provided by solar power, further increasing the share of renewable energy is anticipated.                                                                                                                                                                                                                                                                                   |
| Water management and consumption                                   | Water stress in the area considered to be low; precipitation 300 – 500mm predominately in wet season from December to March. Water supply is planned from groundwater boreholes; groundwater testing and modelling indicating sufficient supply for the project without impacting the supply for local communities, despite decreasing rainfall in recent years. Potential for heavy rainfall events; high riverine flood risk. Stormwater management is planned for 50 year 24h event and 100 year event in sensitive areas.        |
| Pollution prevention                                               | Due to acid buffering capacity, the tailings are geochemically classified as non-acid forming. Flotation technology may imply use of hazardous reagents.                                                                                                                                                                                                                                                                                                                                                                             |
| Air quality                                                        | Impact depending on distance to settlements, assuming diligent operation practice risks are seen as low. The concentrate will be bagged and transported in oversea containers, minimising dust emissions.                                                                                                                                                                                                                                                                                                                            |
| Tailings management                                                | TSF for 9.5 Mt tailings required; TSF will be designed according to Equator Principles.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Waste management                                                   | No relevant information available for review at this stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Hazardous materials management                                     | No relevant information available for review at this stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Noise and vibration                                                | Impact depending on distance to settlements after resettlement, assuming diligent operation practice risks are seen as low.                                                                                                                                                                                                                                                                                                                                                                                                          |
| Protected areas and biodiversity                                   | Project area consists of grass savannah and trees concentrated along streams; the mine site is not close to any protected or key biodiversity area. Biodiversity management plan is envisaged after finalising permits                                                                                                                                                                                                                                                                                                               |
| Mine closure                                                       | No detailed information on mine closure available for review at this stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Social and socio-economic issues</b>                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Community health, safety and security                              | Project is located 8 km away from the township of Maniry (~2,000 inhabitants in the district); nearest larger settlement 25 km southeast is the commune of Ampanihy (~25,000 inhabitants; 2006 census). Project area is sparsely settled, although smaller settlements need to be relocated. Local economy predominately subsistence and cattle farming; ASM activities on semi-precious gemstone existing. Anticipating a diligent resettlement process, negative impact on the local population is considered in general low risk. |
| Dialogue and engagement with                                       | Evion is stating constructive dialogue with local communities and a positive perception of the project. Though, reports on conflict potential due to                                                                                                                                                                                                                                                                                                                                                                                 |

| ESG category                                                                                                                    | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| communities and stakeholders                                                                                                    | resettlement exists (see Mongabay (2023)). A formal complaints and grievances process had been recommended (09/23)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Land acquisition and involuntary resettlement  | Five villages with around 500 people population are located in the area, additional several tombs have to be relocated. A dedicated Resettlement Action Plan will be developed; reports on conflict potential due to resettlement exists (see Mongabay (2023)).                                                                                                                                                                                                                                                                                                                                                                   |
| Occupational health & safety management                                                                                         | No information on OHS management practice at this stage. No health or safety incidents have been recorded at Evion in the last 2 years and evidence was provided of sound OH&S practices (Digbee ESG report). Project is located in dengue and malaria region.                                                                                                                                                                                                                                                                                                                                                                    |
| Workers' rights                                                                                                                 | Madagascar scores 65 / 100 in the Labour Rights Index. Some ASM activities in the area. No information on specific workers' rights situation at Evions operations available for review.                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Gender and diversity                                                                                                            | No information available at this project stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Local value added and community development                                                                                     | Permanent workforce is stated at 385; Evion is committed to employ 98 % Malagasy staff; necessary non-national workforce in senior management and technical positions is planned to be replaced with national workers over time. An accommodation village is planned to benefit local economy. Operational fire protection is planned to generally protect the area against bush fires, which are assumed to increase due to climate changes. Various CSR measures since 2017 (e.g. education / healthcare system; food donations; training of locals). Company tax rate is 20% and a royalty of 2% is applied to graphite sales. |
| <b>Governance</b>                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Legal compliance                                                                                                                | Completion of ESIA and granting of mining permit / licenses pending (as of November 2022). No evidence on any breaches of law by Evion found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Management practices                                                                                                            | Corporate governance and management policies on company level available, due to the early stage of the project evidence of practice on mine site not yet available; compliance with IFC performance standards as well as ICMM performance expectations reported. Evion was rated "BB" by Digbee ESG (2023).                                                                                                                                                                                                                                                                                                                       |
| Transparency and reporting                                                                                                      | Listed on ASX; information for investors, reports on financial accounts and shareholder structure available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Business ethics                                                                                                                 | Madagascar scores 25/100 in the Corruption perception Index; Madagascar is an EITI country, Whistleblower policy in place.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

Table 45. ESG features of Maniry project, Madagascar

#### 4.14.4 Further reading

Black Earth Minerals NL (2022): DFS forecasts strong returns for Maniry Project.

<https://announcements.asx.com.au/asxpdf/20221103/pdf/45h5pgr26pnhyg.pdf> (accessed: 03.11.2023)



Digbee ESG (2023): Evion Group – Digsbee ESG Report Summary. <https://eviongroup.com/wp-content/uploads/2023/10/ESG-Review-Summary.pdf> (accessed: 08.11.2023)

Evion Group NL (2023): Evion Company Update – Africa Down Under presentation (7th Sep 2023). <https://eviongroup.com/investor-centre/> (accessed: 03.11.2023)

Mongabay (2023): Madagascar: What happens to villagers when a graphite mine comes knocking? <https://news.mongabay.com/2023/04/madagascar-what-happens-to-villagers-when-a-graphite-mine-comes-knocking/> (accessed: 08.11.2023)



## 4.15 Minim-Martap bauxite (Al) project (Cameroon)

Information as of 10/2023

### 4.15.1 General project background

|                                    |                                                                                                                                                                                                                                                |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Bauxite                                                                                                                                                                                                                                        |
| <b>Location</b>                    | Adamaoua, Cameroon<br>6°27' N, 13°59' E, 1,150 – 1,400 m.a.s.l.                                                                                                                                                                                |
| <b>License type</b>                | Exploration license (1,400 km <sup>2</sup> ), Mining license pending                                                                                                                                                                           |
| <b>License owner / operator</b>    | Canyon Resources Ltd. (public company)                                                                                                                                                                                                         |
| <b>Contact</b>                     | 945 Wellington Street, West Perth,<br>Western Australia 6005, Australia<br><a href="https://www.canyonresources.au.com">https://www.canyonresources.au.com</a><br><a href="mailto:info@canyonresources.au.com">info@canyonresources.au.com</a> |
| <b>Project status</b>              | Feasibility complete                                                                                                                                                                                                                           |
| <b>Possible production by 2030</b> | Yes, announced for 2026                                                                                                                                                                                                                        |



Figure 34. Minim Martap project location, Cameroon

### 4.15.2 Economic assessment

#### General project background:

The bauxite plateau area of North and Central Cameroon has been known as a bauxite resource since the 1950s. Within these plateaus, the Minim-Martap bauxite project has intermediate tonnages but in global comparison one of the highest  $\text{Al}_2\text{O}_3$  grades, encouraging the operator to commercialise Direct Shipping Ore. Minim-Martap is located within the Central Cameroon Shear Zone, which consists of predominantly metamorphosed Proterozoic sediments, Cambrian granites and more recent basalts from the Cameroon Volcanic Line. The presence of bauxite relates predominantly to the leaching of all other elements from the lateritic section, especially Si and Fe, leaving Al present within the very stable series of Al hydroxides of gibbsite and boehmite. At Minim-Martap bauxite is present in the top 10 to 15 m of the lateritic profile with grades between 35 % and 62 %  $\text{Al}_2\text{O}_3$ . The project comprises three tenements referred to as Minim-Martap and Makan, which resulted from bauxitisation of granites (higher  $\text{Al}_2\text{O}_3$  and  $\text{SiO}_2$ , lower  $\text{Fe}_2\text{O}_3$  grades) as well as Ngaoundal formed from basalts (lower  $\text{Al}_2\text{O}_3$  and  $\text{SiO}_2$ , higher  $\text{Fe}_2\text{O}_3$  grades). The owner seeks investment for rail upgrades (until 2032), mine construction and port upgrades. Operation is planned to commence in 2025, with a ramped up of production until 2031, with steady production from 2032 onwards.

#### Project description:

|                                    |                                                                                                                                                                                                                     |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Laterite                                                                                                                                                                                                            |
| JORC compliant Reserves            | 108.91 Mt @ 51.1 % $\text{Al}_2\text{O}_3$                                                                                                                                                                          |
| Share of global bauxite reserves   | 0.4 % ( <i>USGS estimate global bauxite reserves of 30,000 Mt</i> )                                                                                                                                                 |
| JORC compliant resources           | 1027 Mt @ 45.3 % $\text{Al}_2\text{O}_3$                                                                                                                                                                            |
| Share of global bauxite resources  | 1.4 % ( <i>USGS estimate global bauxite resources of 75,000 Mt</i> )                                                                                                                                                |
| Waste to ore ratio (whole orebody) | 0.3                                                                                                                                                                                                                 |
| Annual production                  | 6.4 Mt of bauxite from 2032 onwards                                                                                                                                                                                 |
| Life of mine                       | 20 years                                                                                                                                                                                                            |
| Investment required                | US\$ 253m (refers to initial CAPEX for mine construction)                                                                                                                                                           |
| Net present value (NPV)            | US\$ 452m (based on a long-term bauxite price of US\$ 45.22/t FOB and a discount rate of 8 %)                                                                                                                       |
| Share of global Al production      | 1.7 % ( <i>USGS estimate global bauxite production of 380 Mt</i> )                                                                                                                                                  |
| Value addition potential           | Alumina production could take place in Cameroon, but a long lasting mine supply into an Alumina smelter would have to be demonstrated first, as smelting operation are longer term investments, compared to mining. |

#### Mining and processing:

- Conventional open pit methods employing sub-horizontal free dig mining of Direct Shipping Ore bauxite (~51 %  $\text{Al}_2\text{O}_3$ , 2 %  $\text{SiO}_2$ ) from discrete plateaus in three pits, namely Beatrice South, then Raymonde-East and subsequently Danielle-Central.

- The ore will be hauled by truck to the rail station near the town of Makor. Loaders will load the bauxite from the stockpile into the train wagons. The trains will transport the product to the Port of Douala, where the ore will be transported via conveyor to the bulk storage shed and subsequently loaded on barges, which will tranship the ore to capsize vessels for export to market.
- The operating expenditures are reported at US\$ 23.95/t for a 51.1 %  $\text{Al}_2\text{O}_3$  export product facing an expected initial selling price of US\$ 35/t FOB. The company expects an increase of the price to long-term US\$ 45/t FOB.

**BGR assessment and comments:**

- The deposit is a high-grade, intermediate-tonnage operation with a low waste to ore ratio of 0.3. The relatively long life of mine (20 years) can be positive for the development of the region. Resource expansions are possible due to the occurrence of 62 bauxite plateaus in the Canyon tenements, which have not been drill-tested so far.
- The Project is 100% owned by Camalco, a wholly owned subsidiary of Canyon. Upon the grant of a mining permit, an entity of the State will be granted 10 % ownership of Camalco, free of charge. Up to an additional 25 % ownership may be acquired via direct investment by the entity of the State.
- Canyon assumes bauxite prices of US\$ 35/t (initial) to US\$ 45/t (long-term). At present, these prices appear to be rather overestimated and long-term forecasts are difficult. However, the high  $\text{Al}_2\text{O}_3$  grades in combination with low  $\text{SiO}_2$  contents may ensure the project remains profitable over time.
- The project is accessible by road and rail within ~500 km from the capital Yaoundé. The mine site infrastructure does not involve any processing of bauxite, so power consumption is presumably low. Water consumption will depend on how much water will be needed for dust suppression during mining. The accommodation will house 100 % of the small expatriate workforce and 50 % of the Cameroonian workforce with the remaining 50 % of Cameroonians assumed to be employed from local population centres. In total, the project owner plans to directly employ up to 625 Cameroonians. The mine site is connected to the inland rail facility near Makor railway station via 60 km of an upgraded national road. The Ngaoundal permit puts potential mining areas even as close as 5 km to the railhead. The government confirmed to substantially upgrade the rail line between the towns of Bélabo and Ngaoundéré. Canyon signed a Memorandum of Understanding with the Port of Douala on a mineral terminal for the transport, storage, handling and export of bauxite.

### 4.15.3 ESG assessment

Due to the early stage of the project detailed information on several management and ESG aspects are not yet available. In 10/2022 the company was granted a certificate of Environmental Compliance. To date, no ESG issues have been identified that preclude responsible investment, results of ongoing assessments would be needed. Environmental risks are considered to be low, stakeholder engagement is widely in place.

| ESG issue                                                          | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Environmental management                                           | A completed detailed ESIA was submitted to Ministry of Environment and Nature Protection (MINEPDED) and Ministry of Mines in June 2021. The company states that the ESIA is aligned with international standards, frameworks, and guidelines (including the IFC Performance Standards and Equator Principles). No reports on incidents found.                                                                                                                                                                                                                                                                                                                                                                                                         |
| Efficient use of energy, renewable energy, GHG emissions reporting | There is currently not enough information on emissions. In 2021, 62.9 % of installed electricity generation was from renewables (biofuels and waste).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Water management and consumption                                   | Water stress in the area is considered to be low. The area is subject to a significant wet season. Potential for heavy rainfall events; medium to riverine flood risk. Appropriate measures to manage stormwater during and immediately after these events are planned to be in place prior to commencement of mining operations. Bauxite stockpiles and transport have been designed with consideration for weather. As no processing of the ore will take place on site, water consumption will be minimal and will only be required for general office and accommodation needs. Hydrogeological studies have been completed and provide a high degree of certainty that the project will not impact the local water supply or nearby watercourses. |
| Pollution prevention                                               | No use of hazardous substances is necessary as no further processing of the ore takes place and the ore is shipped as direct shipping ore.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Air quality                                                        | Dust levels are high at the mine site and transport areas. Dust suppression will be implemented either by water or a binding agent on unsurfaced roads and areas frequented by vehicles.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Tailings management                                                | There is currently no need for a TSF, as the ore is only crushed and then shipped as direct shipping ore.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Waste management                                                   | The open pit mine will initially be developed in three plateau areas, and will employ a strip-mining style operation, with waste material being backfilled into mined-out plateau areas. The development of waste dumps and large stockpiles is limited if not absent due to the characteristics of the mining process. The ESIA includes studies on mining waste.                                                                                                                                                                                                                                                                                                                                                                                    |
| Hazardous materials management                                     | No relevant information available for review at this stage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Noise and vibration                                                | The company does not plan to use explosives. Noise and vibration can be managed through diligent mine operation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

| ESG issue                                                 | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Protected areas and biodiversity                          | Flora and fauna surveys found no endangered flora or fauna or significant impact from the project. Project not located in or close to a key biodiversity land area.                                                                                                                                                                                                                                                                                          |
| Mine closure                                              | As part the ESIA the company has completed a detailed mine closure and rehabilitation plan including a constant progressive rehabilitation and revegetation of the recently mined areas within the three identified bauxite plateaux.                                                                                                                                                                                                                        |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Community health, safety and security                     | Several villages and towns are located within proximity of the project including the towns of Minim and Martap, which are situated close to the Minim Martap and Makan exploration licenses, and Ngaoundal (>35,000 inhabitants; urban centre), which is near the centre of the Ngaoundal exploration license. Mitigation measures to be implemented include, among others, a traffic awareness campaign and a groundwater and surface monitoring programme. |
| Dialogue and engagement with communities and stakeholders | The company states that as part of the ESIA for exploration, stakeholder engagement is conducted regularly and continuously with all local communities (including hamlets and villages around the mine site, along the road and the rail corridor) and all relevant national and regional government departments and representatives following Cameroon regulations and international best practice (i.e. aligned with the IFC Performance Standards).       |
| Land acquisition and involuntary resettlement             | No detailed information on the company's resettlement policy available. However as the site is close to villages potential impact on socio-economic activities can be expected. Anticipating a diligent resettlement process, if necessary, negative impact on the local population is considered in general low risk. The mine site is not close to any cultural heritage site.                                                                             |
| Occupational health & safety management (OHS)             | No information on OHS management practice available. No records of health and safety incidents available. Project is located in malaria region.                                                                                                                                                                                                                                                                                                              |
| Workers' rights                                           | According to the Labour Rights Index 2022 for Cameroon (59/100), Cameroon is rated "Basic Access to Decent Work". ASM activities in the area are not known. No information on specific workers' rights situation at the companies' operations available for review.                                                                                                                                                                                          |
| Gender and diversity                                      | The Company intends to consider the recommendations and guidance in the ASX Corporate Governance Council's Principles and Recommendations. The company has a diversity strategy.                                                                                                                                                                                                                                                                             |
| Local value added and community development               | The company expects to create 625 direct Cameroonian jobs during operation and many more indirect jobs through supporting industries. The Cameroon government retains a 5 % royalty tax, a 1 % community development fund and 30 % corporate tax. The UNICEF Multidimensional Poverty Index 2023 estimates that 43.6 % of the population in Cameroon (~12 million people in 2021) are poor, while a further 17.6 % are classified as at risk of poverty.     |

| ESG issue                  | Assessment                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Governance</b>          |                                                                                                                                                                                                                                                                                                                                                                  |
| Legal compliance           | Through its subsidiary CAMALCO S.A., Canyon Resources was granted three bauxite exploration permits, namely Minim-Martap, Makan and Ngaoundal (1,400 km <sup>2</sup> ). Mining license for Minim-Martap is pending. No indication of any violation of the law found.                                                                                             |
| Management practices       | Corporate governance policies on company level available, but very limited information on management practices, evidence of practice on mine site is not yet available.                                                                                                                                                                                          |
| Transparency and reporting | Canyon has a public disclosure policy and is listed on the ASX. Cameroon joined the EITI initiative in 2007.                                                                                                                                                                                                                                                     |
| Business ethics            | The company has some general ethics policies (e.g. code of conduct) available online on its Corporate Governance section, however, no information on management practices. Cameroon consistently ranks in the bottom half of the Transparency International's Corruption Perceptions Index (140 of 180 in 2023). The project is not located in a high-risk area. |

**Table 46. ESG features of the Minim-Martap project, Cameroon**

#### 4.15.4 Further reading

Canyon Resources Ltd. (2022): Positive BFS for Canyon's Minim Martap Bauxite Project. <https://minedocs.com/23/Martap-BFS-6212022.pdf> (accessed: 27.10.2023)



## 4.16 Molo gneiss-hosted graphite project (Madagascar)

Information as of 01/2024

### 4.16.1 General project background

|                                        |                                                                                                                                                                                                   |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>               | Graphite                                                                                                                                                                                          |
| <b>Location</b>                        | Tulear region, Madagascar<br>23°59' S, 45°7' E                                                                                                                                                    |
| <b>License type</b>                    | Exploitation permit PE 39807 (175 km <sup>2</sup> )                                                                                                                                               |
| <b>License owner / operator</b>        | NextSource Materials (public company)                                                                                                                                                             |
| <b>Contact yes</b>                     | Exchange Tower, 130 King St West                                                                                                                                                                  |
| <b>Direct contact established: Yes</b> | Toronto M5X 2A2 Canada<br><a href="https://www.nextsourcematerials.com">https://www.nextsourcematerials.com</a><br><a href="mailto:info@nextsourcematerials.com">info@nextsourcematerials.com</a> |
| <b>Project status</b>                  | Operating (phase 1), expansion planned (phase 2)                                                                                                                                                  |
| <b>Possible production by 2030</b>     | Already in production (phase 1); Phase 2 could go into production before 2030                                                                                                                     |



Figure 35. Molo project location, Madagascar



### 4.16.2 Economic assessment

#### General project background:

Molo was originally drill-tested in 2012, with a maiden Indicated and Inferred Resource published the same year. The deposit consists of various zones of mineralised graphitic gneiss. Mineralisation strikes approximately north-south, dipping between 75 and 80 degrees to the west and has been sub-domained into a low-grade and high-grade domain based on carbon grade characteristics. Thicknesses vary between 60 – 260 m (low-grade domain) and up to 60 m (high-grade domain). An updated feasibility study was released in 2019, based on 17,000 t graphite concentrate per year over a 30-year mine life (phase 1). Production started in 2023, with phase 1 mining operations currently being optimised to reach nameplate capacity. An updated feasibility study for a mine expansion to 150,000 t concentrate per year was published in late 2023.

#### Project description:

|                                                         |                                                                                                                                                                                                                                                                        |
|---------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                                        | Disseminated flake graphite                                                                                                                                                                                                                                            |
| Ni 43-101 compliant reserves                            | 22.4 Mt @ 7.02 % C                                                                                                                                                                                                                                                     |
| Share of global graphite reserves                       | 0.5 % ( <i>USGS estimate global graphite reserves of 320 Mt</i> )                                                                                                                                                                                                      |
| Ni 43-101 compliant resources<br>(Measured & Indicated) | 100 Mt @ 6.3 % C                                                                                                                                                                                                                                                       |
| Share of global graphite resources                      | 0.8 % for ( <i>USGS global graphite resources of 800 Mt</i> )                                                                                                                                                                                                          |
| Waste to ore ratio (whole orebody)                      | 0.5 (Phase 1). 0.3 (Phase 2)                                                                                                                                                                                                                                           |
| Annual production                                       | Phase 1: 240,000 t of ore, 17,000 t graphite concentrate<br>(96 – 98 %)<br>Phase 2: 2.5 Mt of ore (Phase 2), 150,000 t graphite concentrate<br>(96 – 98 %)                                                                                                             |
| Life of mine                                            | 30 years (Phase 1), 26 years (Phase 2)                                                                                                                                                                                                                                 |
| Investment required                                     | US\$ 161.7m (additional investment for mine expansion phase 2)                                                                                                                                                                                                         |
| Net present value (NPV)                                 | US\$ 370m (post tax with 8 % discount rate)                                                                                                                                                                                                                            |
| Share of global graphite production<br>(Phase 2)        | 15 % ( <i>USGS estimate global graphite production of 1 Mt</i> )                                                                                                                                                                                                       |
| Value addition potential                                | The company is planning to develop turn-key processing facilities for the manufacture of anode active materials, sourcing flake graphite from the Molo Graphite Mine and, if required and where appropriate, from qualified flake graphite feedstock of third parties. |

#### Mining and processing:

- The deposit will be mined via conventional open pit methods employing drilling, blasting, excavating and hauling. Phase 1 mining operations are currently being optimised, with a planned ore production rate of 240,000 t/a (17,000 t/a graphite concentrate). Phase 2 of production consists of a modular expansion to increase production capacity and envisages an ore production of 2.5 Mt/a, with a waste-to-ore ratio of 0.3.

- Processing includes three crushing stages, followed by milling, flash and rougher flotation. The material then gets subjected to primary concentrate cleaning, fine flake cleaning and attrition cleaning. The concentrate gets thickened, dried and screened into four size fractions: +48 mesh, -48 +80 mesh, -80 +100 mesh and -100 mesh.
- NextSource Materials assumed OPEX of US\$ 566/t of finished concentrate for phase 1 and US\$ 392/t for phase 2, including mining, processing and trucking transport with the port of Tulear viewed as the primary option of shipping.

### **BGR assessment and comments:**

- Molo is a large tonnage, high-grade and large flake-size deposit. The waste to ore ratio of 0.3 is considered to be low.
- The operating expenditures of US\$ 566/t of finished concentrate for phase 1. Following expansion to phase 2, the company states an average life-of-mine mine site operating cost of US\$ 392 per tonne concentrate which is within an expectable range for a high tonnage operation.
- The company's modular approach reduces build time and associated costs, thus overall de-risking phase 2 production of Molo.
- A non-binding MOU exists with POSCO for a strategic collaboration, which could involve an equity investment into the company. The MOU further envisages the potential for a definite offtake agreement for 30,000 t per year of graphite concentrate and 10,000 to 15,000 t of spheronized and purified graphite over a ten year period.
- The company gives an average life-of-mine selling price of US\$ 1,191/t across all flake sizes and grades that are expected to be produced from the Molo deposit. This price is based on current market prices provided by commercial reporting agencies Benchmark Intelligence and Fastmarkets.
- The neighbouring Green Giant project that is also in possession of NextSource but development currently halted in favour of the Molo project, may benefit in the future from infrastructure development at the Molo site, as several facilities (e.g. transport infrastructure, processing, power supply, staff facilities etc.) may also be used for later operation at Green Giant.

### **4.16.3 ESG assessment**

The level of publicly available project information is good. No major ESG issues were identified that would preclude responsible investment. The operator comprehensively documents its corporate policies and management systems. Environmental risks are considered to be low, stakeholder engagement and OHS management is widely in place.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Environmental Management                                           | Environmental management system established with three focal areas: water, dust and biodiversity. Two environmental incidents occurred in 2023: an uncontrolled release of process water onto plant grounds with seepage to neighbouring land as well as an uncontrolled release of sewage from equipment malfunction. Both incidents resulted in the establishment of additional containment infrastructure to prevent any release into the environment from a recurrence.                                                                                                                                                                         |
| Efficient use of energy, renewable energy, GHG emissions reporting | Scope 1 and 2 emissions published annually as part of ESG report. Scope 3 emissions will be reported once data collection systems have been expanded. The company has completed commissioning and achieved full operations of a solar and battery hybrid power plant in 2023 which is designed to generate up to 35 % of the mine's steady-state power requirements with the remainder coming from diesel generators. Due to the remote location of the project there is no access to electricity from the national grid. The company plans to install a battery energy storage systems to assume a grid forming role during night-time.            |
| Water management and consumption                                   | Water for mining and beneficiation processes is pumped from a well field. Potential impacts of mining activities on surface and groundwater relate to mine dewatering, wellfield abstraction, dirty water run-off, run-off reduction and potential contaminant seepage from the co-disposal facility and material reject dump; the company states that none of the identified potential impacts posed a high or serious risks and that these can be mitigated by the water management plan. Measures include the reuse of water, storm water management, water monitoring and waste capping systems. Water stress in the area considered to be low. |
| Pollution prevention                                               | Company reports predominantly secondary sulphate minerals associated with ore, tailings and waste rock; AMD potential is seen as low in the short-term but potentially higher in the long-term, specifically relevant for post-closure. The company plans appropriate capping systems to manage the long-term post closure water quality emanating from residual waste product. Flotation technology may imply use of hazardous reagents, in case of graphite flotation usually fuel oil or kerosene are applied.                                                                                                                                   |
| Air quality                                                        | Scarcely populated area, dust suppression using borewater to be employed. Considered low risk.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Tailings management                                                | Phase 1 will use dry-stack tailings, tailings co-disposed with the waste rock generated as part of the open cast mining processes. A detailed design has been completed to allow for the upgrade to a more conventional cyclone facility with expansion to Phase 2 production. The company is working to align waste management and tailings facilities with the ICMM's Global Industry Standards on Tailings Management.                                                                                                                                                                                                                           |
| Waste management                                                   | No available information on waste management policy. The company's ESG report for 2023 states a commitment to ensure disclosure in 2024. Waste rock will be co-deposited with tailings.                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hazardous materials management                            | Hazard reports on graphite dust exposure and silica dust exposure were completed as part of feasibility study including the evaluation of any existing and new preventative and mitigating safeguards/controls. Flotation, leaching and use of required reagents is considered low risk assuming responsible handling; no specific information on used reagents available.                                                                  |
| Noise and vibration                                       | Local villages in the project area; noise and vibration risk considered to be low due to >10 km distance to mine site.                                                                                                                                                                                                                                                                                                                      |
| Protected areas and biodiversity                          | The project is not located in or close to any key biodiversity areas or other designated protected areas.                                                                                                                                                                                                                                                                                                                                   |
| Mine closure                                              | A conceptual closure plan has been developed which indicates a positive, achievable and sustainable post closure land use. Post-closure land use include grazing land, agricultural development and managed domestic water supply. 43-101 Technical Report (2017) states calculated closure costs of around US\$ 3.0m - 3.7m.                                                                                                               |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Community health, safety and security                     | Project location approx. 13 km NE of the local village of Fotadrevo. Potential negative impacts from the mine on local communities are considered low.                                                                                                                                                                                                                                                                                      |
| Dialogue and engagement with communities and stakeholders | Ongoing local and regional stakeholder and community engagement including site visits and separate consultations through the Office Nationale pour l'Environnement. Support of host community through a number of projects and interventions in the fields of infrastructure and education.                                                                                                                                                 |
| Land acquisition and involuntary resettlement             | Application for an amendment of the requisite social, resettlement, environmental and construction approvals required for Phase 2. Grievances from discussions on land compensation; all matters resolved as of 31 Oct 2023 and compensation levels formally agreed upon. There are no cultural heritage sites in the area.                                                                                                                 |
| Occupational health & safety management                   | Two hazard reports on graphite dust exposure and silica dust exposure were completed. Focus on risk minimisation as well as safety and competency training as part of implementing a company-wide OHS management system based on ISO 45001. Working towards formal certification.                                                                                                                                                           |
| Workers' rights                                           | Madagascar scores 65/100 in the Labour Rights Index. 67 % of workforce deemed local and regional. 174 permanent employees, 45 contractors. Ongoing awareness training provided, including safety and fit-for-purpose on-the-job training for all employees. No company track record of conflicts/strikes.                                                                                                                                   |
| Gender and diversity                                      | Percentage of female employees: 10 %. Percentage of female employees in management (top and senior): 14 %.                                                                                                                                                                                                                                                                                                                                  |
| Local value added and community development               | Local value contribution considered generally high. The project is the largest employer in the region, employing 174 people; 64 % deemed local and regional. The company has initiated 12 internship and on the job training opportunities in services roles, designed to lead to longer-term employment opportunities on the mine and in the region. Community development projects such as investing in local educational infrastructure, |

| ESG category               | Assessment                                                                                                                                                                                                                                                                                                                          |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | construction of sports facilities, solar street lighting and agricultural training.                                                                                                                                                                                                                                                 |
| <b>Governance</b>          |                                                                                                                                                                                                                                                                                                                                     |
| Legal compliance           | Relevant policies in place. No indication of any breaches of law found.                                                                                                                                                                                                                                                             |
| Management practices       | Comprehensive and structured information on ESG policies and management. Working towards ISO 45001 certification.                                                                                                                                                                                                                   |
| Transparency and reporting | Listed on the Toronto Stock Exchange; extensive information for investors and reports on financial accounts and shareholder structure available. Annual ESG reporting with reference to the GRI Standards and in alignment with other relevant formats including the ICM and TCFD.                                                  |
| Business ethics            | Madagascar scores 25/100 in the corruption perception index. No indication of unethical company practices found. Financial accounts according to stock listing requirements. Madagascar is an EITI country. The project is not located in a conflict-affected and high-risk area (CAHRA). Company with registered office in Canada. |

Table 47. ESG features of Molo project, Madagascar

#### 4.16.4 Infrastructure assessment

##### Potential Investment Needs:

- Road Infrastructure: Investments can be considered to modernize impassable routes during rainy season in order to maintain access of the mine.
- Renewable Energy Ventures: Investments can be considered to ensure full primary power supply by solar energy.
- Water Supply: Investments can be considered to further optimize the mine water management.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | The Molo project is located in the Toliara Province in the south of Madagascar, near the Green Giant Vanadium project. The Molo deposit occurs in a sparsely populated, dry savannah grassland region, which has easy access via a network of seasonal secondary roads radiating outward from the village of Fotadrevo. Fotadrevo has an all-weather airstrip and access to a road system that leads to the regional capital, (and port city) of Toliara and the Port of d'Ehoala at Fort Dauphin.                                            |
| Transport                 | Access to Molo from Toliara (port) is initially via a 70 km paved road (RN 7) to the village of Andranovory. From Andranovory, a secondary all-season road (RN 10) continue to Betioky, a distance of 93 km. From Betioky the Property area can be reached via Ambatry to Fotadrevo, a distance of 105 km (268 km total), or from Betioky to Ejeda, then onwards to Fotadrevo, a distance of 161 km (324 km total). This alternate route from Ejeda to Fotadrevo is used by heavy transports and by all vehicles during portions of the rainy |

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             | <p>season, as the primary route quickly becomes impassable. At the height of the rainy season, both routes to Fotadrevo may be largely impassable. Molo may be reached from Fotadrevo by a fairly well-maintained dirt road. Access to the Molo area from the Port of Ehoala is via the RN 13 over a total distance of 372 km and passes through the municipality of Andalatanosy, Ambatofotsy then through Beraketa and later on through the city of Bekily. The bulk of the road is severely rutted bush track, which during the rainy season from November to March can at times become impassable. Investments can be considered to modernize impassable routes during rainy season in order to maintain access.</p> <p>After completion of the expansion project the combined concentrate for exportation will be 150,000 t. The all-road route from the mine to Tulear port has a bridge restriction of 18 t across the river at Tongabory. To eliminate the bridge restrictions at Tongabory the option to barge loaded trucks from Soalara to Tulear Port was identified for the expansion project. This increases the loading capacity of trucks from 18 to 28 t and reduces the total trucking distance. The barging operation is envisaged to be implemented for the expansion project or, even before during Phase 1 of the project, reducing total fleet requirements and daily convoys. This route, at 210 km to Soalara, is significantly shorter than any other route, thus yielding lower fuel costs and shorter on road transit times. From Soalara the trucks will be moved on the landing craft to Tulear Port, with a short hauling distance from landing dock to warehouse, or direct container loading and exportation.</p> |
| Airport     | <p>With the upgrading of an existing airstrip at Fotadrevo an all-weather airstrip during the 2008 exploration programme, the Project area is now accessible year-round, (except under special circumstance caused by continuous, or multiple days of heavy rain), by air, using private aircraft out of Antananarivo. Flying times to Fotadrevo are roughly 2.5 hours from Antananarivo and 45 minutes from Toliara. Antananarivo is currently serviced by Air France (from Paris), Air Mauritius, (Sir Seewoosagur Ramgoolam International Airport in south-east Mauritius), Air Ethiopia flying from Addis Ababa, (Addis Ababa Bole International Airport), Kenya Airways flying from Nairobi, Kenya (Jomo Kenyatta International Airport) and recently Airlink flying from Johannesburg (O.R. Tambo International airport). Air Madagascar also has regularly scheduled domestic jet and propjet flights throughout the country, including daily flights between Antananarivo and Toliara.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Rail access | <p>In 1992, railways in Madagascar were abandoned in favour of road transport. Based on the existing infrastructure within the province transportation via rail are not suitable for the project. As road infrastructure is adequate, investments to reactivate rail infrastructure are of secondary importance.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Port        | <p>During implementation of the expansion project the Port of Tulear and Port d'Ehoala at Fort Dauphin will be used to transport material in bulk bags with hopper trucks for exportation, the latter for heavyweight equipment importation. The Port of Tulear is viewed as the primary option on the basis of its proximity to Molo with an economical and logistical advantage, lowest warehousing and port handling cost, lowest road transport costs, less political hurdles due to the same province. In previous studies completed prior to the commissioning of Molo Phase 1, the port at Fort Dauphin was expected as the primary port, however the existing road from Molo to Tulear Port was effectively used for transportation of product and goods during the commissioning and ramp up of production and proved to be viable for Phase 1 volumes of cargo movement.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |



|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | Receipt of cargo at Tulear warehouse, a facility with a minimum holding capacity of 2,400 t, will involve product being offloaded into store. Direct loading from truck trailer into shipping containers will be done if possible to increase total handling capacity. The capacity of a 20 ft container is 24 bulk bags (24 t). The capacity of a 40 ft container is 32 bulk bags (32 t). For the initial export shipment (to Qingdao) during Phase 1, all bags were packed into the 20 ft containers. Movement from warehouse facilities to port for vessel loading is by truck, with a maximum trip distance of 6 km.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Energy       | Power is provided to the Phase 1 operation through an independent power provider agreement with CrossBoundary Energy. CrossBoundary Energy use a mixture of solar and thermal generation to meet the Phase 1 demand. The power generation solution (the “Solar Hybrid Plant”) is a hybrid power solution, which consists of a combination of various prime rated diesel power plants, fixed tilt east-west photovoltaic plants and a battery energy storage system to match load profile and operating philosophy. This power generation solution will be expanded to match the increased power demand for full production. Independent of that, it is envisaged providing free standing 20 kWp off-grid solar / solar-diesel hybrid systems to power the various boreholes for process and potable water supply. Investments are needed to ensure full primary power supply by solar energy.                                                                                                                                                                                     |
| GHG emission | The calculation of carbon emissions resulting in a total of 733.8 t of CO <sub>2</sub> -eq emissions from direct energy consumption (i.e., Scope 1). Due to the remote location of the Molo Mine there is no access to electricity from the national grid, therefore requiring the use of on-site generators to produce electricity. The site is already integrating solar hybrid solutions generating up to 35 % of the Molo mine’s steady-state power requirements from renewable energy significantly reducing all-in sustaining costs and carbon emissions by 2,275 t annually.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Water        | The operation will require 180 m <sup>3</sup> /h of raw water. The raw water will be sourced from a well field to be developed. The number of wellfield boreholes is conservatively estimated to be 22 with individual borehole yields expected to be between 8 and 27 m <sup>3</sup> /h as determined from Phase 1 hydrogeological drilling. A Storm Water Management Plan was set up to minimize and manage the loss of the water resource. The dirty water footprint is minimized and the use of dirty water in the ore beneficiation process is optimized. The proposed Storm Water Management Plan measures includes the implementation of Pollution Control Dams and Return Water Dam at the proposed TSF Facility. To optimise the mine water management a dynamic water balance model will be evaluated as part of the detailed design for the expansion. The re-use of dirty water in the mining processes will be maximised to reduce raw water make-up demand and well field abstraction. Investments can be considered to further optimize the mine water management. |

Table 48. Infrastructure assessment of Molo project, Madagascar

#### 4.16.5 Further reading

Erudite (2023): Molo Graphite Mine Expansion – NI 43-101 Technical Feasibility Study Report 2023. [https://www.nextsourcematerials.com/wp-content/uploads/2024/01/Molo\\_Graphite\\_Expansion\\_Feasibility\\_Study\\_2023.pdf](https://www.nextsourcematerials.com/wp-content/uploads/2024/01/Molo_Graphite_Expansion_Feasibility_Study_2023.pdf) (accessed: 28.01.2024)

NextSource Materials (2023): ESG Report 2023. <https://www.nextsourcematerials.com/wp-content/uploads/2023/12/NSM-2023-ESG-Report-Final.pdf> (accessed: 28.01.2024)

## 4.17 Moma heavy mineral sands (-REE) project (Mozambique)

Information as of 08/2023

### 4.17.1 General project background

|                                    |                                                                                                                                                                                                                                |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Titanium (ilmenite, rutile), Zirconium (zircon)                                                                                                                                                                                |
| <b>Other commodities</b>           | REE (monazite)                                                                                                                                                                                                                 |
| <b>Location</b>                    | Nampula, Mozambique<br>16°32' S, 39°39' E, 0 – 30 m.a.s.l.                                                                                                                                                                     |
| <b>License type</b>                | Mining Concession No. 735C (currently valid until 26 August 2029; excl. Nataka)                                                                                                                                                |
| <b>License owner / operator</b>    | Kenmare Resources plc. (public company)                                                                                                                                                                                        |
| <b>Contact</b>                     | Styne House, 4th Floor, Hatch Street Upper<br>Dublin 2, Ireland<br><a href="https://www.kenmareresources.com">https://www.kenmareresources.com</a><br><a href="mailto:info@kenmareresources.com">info@kenmareresources.com</a> |
| <b>Project status</b>              | Production – Operating, Nataka expansion (PFS done)                                                                                                                                                                            |
| <b>Possible production by 2030</b> | Yes, announced for 2025                                                                                                                                                                                                        |



Figure 36. Moma project location, Mozambique

### 4.17.2 Economic assessment

#### General project background:

Moma is one of the world's largest titanium mineral deposits and is located 160 km from the city of Nampula. It is owned and operated by Kenmare Resources, who began exploring for titanium minerals in Mozambique in 1987 and started mining at Moma in 2007. Moma is a heavy mineral sand (placer) deposit, which is located in a sequence of fine to medium grained and silty sands associated with clay units. The heavy minerals fraction of the deposit constitutes about 85 % of ilmenite (Ilm), 5 % of zircon (Zrn) and 2 % of rutile (Rt). It also contains small quantities of monazite. Currently, mining takes place via dredging, processing via Wet Concentrator Plants (WCPs) at the Namalope and Pilivili ore zones. The Company is primarily seeking investment for ongoing feasibility studies on the Nataka ore zone (prefeasibility completed 2022), which represents the largest ore zone at Moma. WCP A (currently at Namalope) is expected to start operation at Nataka around 2025. The WCP concentrates are afterwards upgraded into final Ilm, Zrn and Rt concentrates in the mineral separation plant and a monazite containing product, stored, loaded on barges and finally on bigger vessels for international shipping to the final destinations.

#### Project description:

|                                     |                                                                                                                                                                                                                                                |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                    | Placer                                                                                                                                                                                                                                         |
| JORC compliant reserves             | 1,507 Mt (Nataka 1,274 Mt) @ 2.6 % Ilm, 0.048 % Rt, 0.15 % Zrn                                                                                                                                                                                 |
| Share of global ilmenite reserves   | 6.2 % ( <i>USGS estimate global ilmenite reserves of 650 Mt</i> )                                                                                                                                                                              |
| Share of global rutile reserves     | 1.5 % ( <i>USGS estimate global rutile reserves of 49 Mt</i> )                                                                                                                                                                                 |
| JORC compliant resources            | 7,288 Mt (Nataka 5,119 Mt) @ 2.2 % Ilm, 0.049 % Rt, 0.15 % Zrn                                                                                                                                                                                 |
| Annual production                   | ~40 Mt of excavated ore grading 4.6 % total heavy mineral (THM); Processing: 1,200 kt of heavy mineral concentrates, incl. 1,088.3 kt Ilm (recovery: 91.2 %), 58.4 kt Zrn (recovery: 64.4 %), 8.9 kt Rt (recovery: 68 %), 45.2 kt concentrates |
| Life of mine                        | >30 years                                                                                                                                                                                                                                      |
| Investment required                 | US\$ 281m, including US\$ 225m for Nataka expansion                                                                                                                                                                                            |
| Total in-situ value                 | US\$ 91.07bn ( <i>source: S&amp;P Capital IQ</i> )                                                                                                                                                                                             |
| Share of global ilmenite production | 12.2 % ( <i>USGS estimate global ilmenite production of 8.9 Mt</i> )                                                                                                                                                                           |
| Share of global rutile production   | 9.9 % ( <i>USGS estimate global rutile production of 0.59 Mt</i> )                                                                                                                                                                             |
| Value addition potential            | The production of titanium slag or synthetic rutile would be possible, but this industry is not yet existing in Mozambique.                                                                                                                    |

#### Mining and processing:

- Mining methods include dredging in three artificial ponds, where four dredges feed the three WCPs, namely WCP A, WCP B and WCP C with throughput capacities of 3,250 t/h, 2,400 t/h and 500 t/h, respectively. The dredges cut into the ore at the pond's base, causing the mineralised sand to slump into the pond, where it is pumped to a WCP.

- WCP A has been operating at the Namalope ore zone since 2007 and is expected to move to the Nataka ore zone in 2025. WCP B operates at the Pilivili ore zone and WCP C at the high grade area of the Namalope ore zone, which is inaccessible to the two larger WCPs A and B. Kenmare also has three dry mining areas to supplement ore feed to WCP A and WCP B.
- Processing via the WCPs includes the separation of oversize material, the separation of clay and (gravity) spiral separation. The resulting heavy mineral concentrate consists mainly of ilmenite, rutile, zircon and monazite. In the mineral processing plant, ilmenite, rutile, zircon and monazite are separated into individual products using magnetic, gravity and electrostatic circuits.
- Post-processing, the concentrates are transported via a 2.4 km-long overland conveyor and subsequently onto a 400 m-long jetty, which loads the concentrates onto two company-owned transshipment vessels. The vessels transport the products to a deep-water transshipment point 10 km offshore, where they self-discharge into ocean-going third-party vessels.
- For 2022, Kenmare reported average production costs of US\$ 180/t of separated heavy mineral concentrate, which compared to a record average sales price of US\$ 463/t of separated heavy mineral concentrate.

### **BGR assessment and comments:**

- The deposit is a medium-grade high-tonnage surface operation. The long life of mine (>30 years) can be positive for the development of the region. Kenmare holds prospective concession areas that have not yet been fully explored and offer the potential for further discoveries.
- For 2022, the company reported record sales prices FOB for its average separated heavy mineral products of US\$ 463/t. However, over the past 5 years, the average selling price for Moma concentrates has been US\$ 306/t. In addition, production costs are likely to exceed the reported US\$ 180/t for 2022 due to varying ore grades and clay contents of the sands. Despite this, given its broad range of concentrate products (potentially including rare earth-bearing monazite), Moma appears to be an economically robust project in the face of future market challenges.
- The Moma heavy mineral sand project is located in the northeast of Mozambique, ~210 km south of Nampula. A hydropower supply contract covers 90 % of the electrical energy and 50 % of the total energy demand. Water is sourced from a local aquifer. With chemical-free mining and processing operations, most of the water used at Moma is returned to the aquifer.

### 4.17.3 ESG assessment

The level of publicly available information is good. In 2010, a major ESG incidents in the form of a settling pond breach occurred, causing one fatality and, predominately minor, damages on nearly 400 houses. News reports indicating quick and adequate emergency response actions by Kenmare. In the recent past several ESG incidents occurred which were assessed as minor by Kenmare. Those includes process water overflow and clearing of rehabilitated area by communities for farming. Kenmare's reporting appears transparent and immediate actions respectively procedure review appears adequate. Considering rising clay content in the ore and resulting higher energy intensity, Kenmare states investor pressure on net zero transition while lacking sufficient renewable energy sources as a major business risk.

| ESG issue                                                          | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Environmental management                                           | Environmental management in accordance with ISO 14001; independent audit in 2022 found no significant shortcomings. Minor traces of mercury and manganese were found in the sewage facility, investigation of source ongoing. An increase of 441 % of environmental incidents is due to reclassification of process water overflow as environmental incidents instead of environmental concern.                                                                                                                                                                                                                                                                                                                                                                                    |
| Efficient use of energy, renewable energy, GHG emissions reporting | Electricity contracted from hydropower (90 % of electrical / 50 % of total energy consumption); relative energy intensity will increase due to mining ore with higher clay content and exceed local hydropower capacity. Reliance on backup diesel during wet season due to unreliable power supply; Rotary Uninterruptible Power Supply system installed to reduce diesel use. Reaching net zero aimed for 2040; 6 % reduction in 2021 due to increase in process efficiency and reduction of diesel consumption. GHG emissions reporting in accordance with GHG Protocol and ISO 14064-1; Scope 1: 66,519 t CO <sub>2</sub> -eq; Scope 2: 16,337 t CO <sub>2</sub> -eq; Scope 3: 115,218 t CO <sub>2</sub> -eq. Carbon intensity 0.055 t CO <sub>2</sub> -eq per t of mined ore. |
| Water management and consumption                                   | Humid area with dry and wet season and relatively low water stress. Dredge mining requires high volume of water for the artificial ponds; although recycling rate of 90 % (10 % loss due to seepage) does not require high continuous withdrawal; 49 % surface water / 51 % groundwater, withdrawal intensity 0.58 m <sup>3</sup> per t of mined ore; higher clay content in the ore will require bigger settlement ponds. Kenmare stated stormwater management and reduction of general process water overflow as demanding; extremely high riverine flood risk.                                                                                                                                                                                                                  |
| Pollution prevention                                               | Monazite is naturally radioactive and makes up 18 % in the monazite concentrate, Kenmare states exposure is kept below legal limits by radiation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Air quality                                                        | Kenmare conducts monthly monitoring of air quality; one incident of exceeding dust limits and complains from communities along transport road due to truck transport; pipeline transport system under repair had                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| ESG issue                                                                                                                   | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                             | increased need for road transport, Kenmare increased road watering effort and tree planting to reduce dust emissions.                                                                                                                                                                                                                                                                                                                                                                                |
| Tailings management                                                                                                         | Compliance with Global Industry Standard on Tailings Management stated as 50 %, full compliance aimed for the end of 2024. Construction of elevated tailing dams usually not necessary, depending on topography; although the 2010 dam breach causing one fatality in a nearby village (see Proactive group 2010).                                                                                                                                                                                   |
| Waste management                                                                                                            | 351 t of non-recyclable and organic waste produced in 2022; waste management contractor increased volume of recyclable waste by 32 %; recommissioning of landfill facility delayed to beginning 2023 due to delays of the regulatory approval and theft of landfill lining. Planned enhancement of organic waste separation for composting and use for rehabilitation.                                                                                                                               |
| Hazardous materials management                                                                                              | Kenmare states that no hazardous process chemicals are required. A radioactive gauge was accidentally lost in a mining pond in 2021, the incident was assessed as low risk.                                                                                                                                                                                                                                                                                                                          |
| Noise and vibration                                                                                                         | Proximity to settlements requires special care; no indication of shortcomings.                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Protected areas and biodiversity                                                                                            | The mining concession lies within the Primeiras & Segundas environmental protection area (IUCN category V), home to three endemic plant species classified as endangered. 220 ha of forest excluded from mining, nevertheless experience increasing deforestation due to communities clearing the area for farming as compensation for land occupied by mining operations; Kenmare states it is working towards creating alternatives for the communities and strengthening the conservation status. |
| Mine closure                                                                                                                | Progressive rehabilitation of land; challenge to convince local communities not to cut endemic trees important for biodiversity and soil development. 191 ha of land rehabilitated and 93 ha enhanced in 2022. Lower clay content may result in poorer soil quality compared to pre-mining conditions.                                                                                                                                                                                               |
|  <b>Social and socio-economic issues</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Community health, safety and security                                                                                       | Mining area is located between the towns Toquito and Pilivili (21,000 / 24,000 inhabitants); area densely populated; management practice appears sufficient to prevent lasting negative impact on local communities. Kenmare states providing sufficient quality of drinking water as challenging due to local sanitation habits and general population growth.                                                                                                                                      |
| Dialogue and engagement with communities and stakeholders                                                                   | Continuous engagement with communities through community relation team as well as several working groups and committees dedicated to different topics.                                                                                                                                                                                                                                                                                                                                               |
| Land acquisition and involuntary resettlement                                                                               | Resettlement Action Plans are developed in consultation with the communities; final approval of communities and local authorities is required. 83 houses for resettlement finished in 2022; independent auditing confirms high quality of the housing.                                                                                                                                                                                                                                               |



| ESG issue                                   | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Occupational health & safety management     | OHS policies aligned to ISO 45001 and certified by the National Occupational Safety Association. Healthcare and health education program, on site occupational health centre, annual medical examinations, and malaria treatment. Malaria is a major reason for lost workdays (4,620 workdays in 2022); Kenmare is engaged in malaria prevention on site and in the local communities. 0.45 lost time injuries per million work hours; one fatal work accident occurred in 2020 (Club of Mozambique 2020).                                                                                                         |
| Workers' rights                             | Mozambique scores 71.5/100 in the Labour Rights Index. Freedom of association and right to collective bargaining policy in place; minimum entry wage in 2022 twice the legal minimum wage; salary increase matching inflation rate. Maximum working hours part of employment contracts; age of majority verification before employment. Biennial employee survey to identify grievances.                                                                                                                                                                                                                           |
| Gender and diversity                        | Non-discrimination policy in place. 15 % woman in the workforce, 25 % in senior management; Kenmare states its goal to reach overall 20 % by 2025 as challenging. Maternity leave of four month (legal requirement are two month).                                                                                                                                                                                                                                                                                                                                                                                 |
| Local value added and community development | In 2022, Kenmare invested US\$ 3m in community development programs; Moma Development Association founded as NGO for implementation of community development programs (education, health care). Conservation Agriculture program providing capacity building for farmers; emergency repair after cyclone Ana. Providing interest free loans for local business. 48 % national and 19 % local suppliers; increase of overall national spending from 49 % (2021) to 54 % (2022). 97 % of permanent employees Mozambican; different skill development and trainings programs, including scholarships and internships. |
| <b>Governance</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Legal compliance                            | Relevant licences for mining operation available; no indication of any breaches of law found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Management practices                        | Comprehensive and structured information on ESG management available. Management practice in alignment of IFC Performance Standard. Third party auditing conducted for several management policies.                                                                                                                                                                                                                                                                                                                                                                                                                |
| Transparency and reporting                  | Kenmare subscribed to EITI; listed at LSE and Euronext. Whistleblowing policy and independent reporting system in place; five cases reported in 2022, investigation showed none of them to be substantial.                                                                                                                                                                                                                                                                                                                                                                                                         |
| Business ethics                             | Mozambique scores 25/100 in the Corruption Perception Index; Mozambique is an EITI country. Mandatory annual refreshment training on Kenmare's business ethics for employees. Suppliers are required to align with code of conduct; audited 79 % compliance of suppliers in 2022 (gaps including freedom for association, shortcomings in environmental management). Nampula province neighbouring Cabo Delgado province, which has seen violent conflict with jihadists in the recent past; although the conflict is currently seen as low risk.                                                                  |

Table 49. ESG features of Moma project, Mozambique

#### 4.17.4 Further reading

Club of Mozambique (2020): Employee dies in accident at Kenmare's Moma mine, in Mozambique. <https://clubofmozambique.com/news/employee-dies-in-accident-at-kenmares-moma-mine-in-mozambique-170474/> (accessed: 06.12.2023)

Kenmare Resources Plc. (2022a): Annual Report and Accounts 2022. [https://www.kenmareresources.com/application/files/3916/8070/3830/Kenmare\\_Resources\\_2022\\_Annual\\_Report.pdf](https://www.kenmareresources.com/application/files/3916/8070/3830/Kenmare_Resources_2022_Annual_Report.pdf) (accessed: 01.09.2023)

Kenmare Resources plc. (2022b): Sustainability Report 2022. [https://www.kenmareresources.com/application/files/3716/8129/5633/Kenmare\\_Resources\\_2022\\_Sustainability\\_Report.pdf](https://www.kenmareresources.com/application/files/3716/8129/5633/Kenmare_Resources_2022_Sustainability_Report.pdf) (accessed: 24.08.2023)

Kenmare Moma Development Association (2022): Annual Report 2022. [https://www.kenmareresources.com/application/files/2816/8122/9655/Kenmare\\_Resources\\_2022\\_KMAD\\_Annual\\_Report\\_English.pdf](https://www.kenmareresources.com/application/files/2816/8122/9655/Kenmare_Resources_2022_KMAD_Annual_Report_English.pdf) (accessed: 24.08.2023)

Proactive Group Holdings Inc (2010): Kenmare's close local ties have been key in the wake of Moma incident. <https://www.proactiveinvestors.co.uk/companies/news/19139/kenmares-close-local-ties-have-been-key-in-the-wake-of-moma-incident-22871.html> (accessed: 06.12.2023)

## 4.18 Motheo (Tshukudu) sediment-hosted Cu project (Botswana)

Information as of 07/2023

### 4.18.1 General project background

|                                    |                                                                                                                                                                                                                           |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Copper                                                                                                                                                                                                                    |
| <b>Other commodities</b>           | Silver / palladium, platinum (potentially)                                                                                                                                                                                |
| <b>Location</b>                    | Ghanzi region, Botswana<br>21°13' S, 22°27' E, 1250 – 1300 m.a.s.l.                                                                                                                                                       |
| <b>License type</b>                | Mining license (covers T3 open pit)                                                                                                                                                                                       |
| <b>License owner / operator</b>    | Sandfire Resources Ltd. (public company)                                                                                                                                                                                  |
| <b>Contact</b>                     | 10 Kings Park Road, Level 2<br>West Perth, Western Australia 6005, Australia<br><a href="https://www.sandfire.com.au">https://www.sandfire.com.au</a><br><a href="mailto:admin@sandfire.com.au">admin@sandfire.com.au</a> |
| <b>Project status</b>              | Preproduction - Commissioning                                                                                                                                                                                             |
| <b>Possible production by 2030</b> | Initial production started in 2023; full production to be expected before 2030                                                                                                                                            |

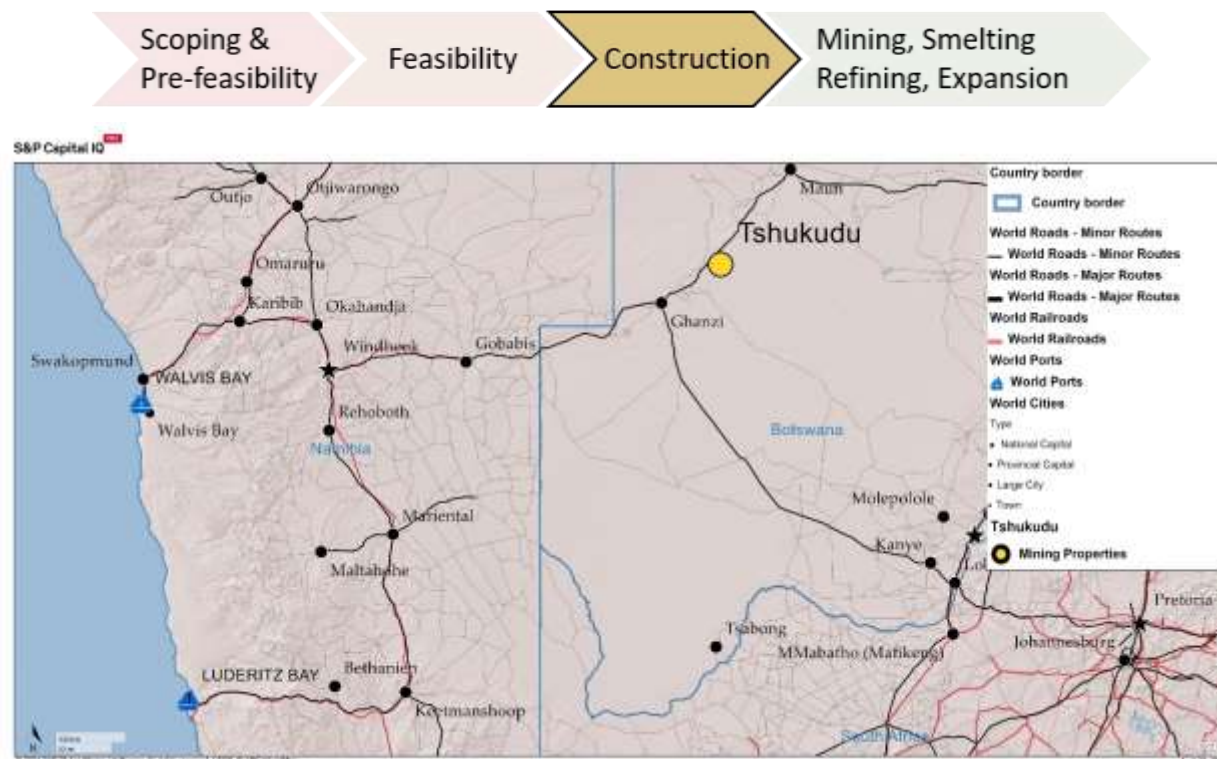


Figure 37. Motheo project location, Botswana

### 4.18.2 Economic assessment

#### General project background:

The Motheo Copper Project is located in the Kalahari Copper Belt and is a medium-tonnage, high-grade copper deposit containing considerable amounts of silver. Mineralisation strikes (for approximately 2 km strike length) and dips parallel to a 20-30 degree north-west dipping thrust zone, and is considered to be a structurally hosted, epigenetic deposit that formed synchronous with regional deformation. Cumulative total true width of mineralisation within the thrust zone ranges between 10 and 80 m, with primary sulphide Cu mineralisation hosted within quartz-carbonate veins and disseminations. The project comprises the T3 (Mining Licence granted) and A4 open pits with the latest expansion case definite feasibility study being completed in 08/2022 targeting an annual production of 50 kt of contained Cu. Recently, first concentrate was produced at Motheo. The owner seeks investment for the project expansion targeting the A4 open pit as well as for the construction of a photovoltaic plant and a battery energy storage system.

#### Project description:

|                                                    |                                                                                                                                                                                                                       |
|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                                   | Sediment-hosted Cu-Ag sulphides                                                                                                                                                                                       |
| JORC compliant reserves                            | 49.6 Mt @ 0.94 % Cu, 13.1 g/t Ag                                                                                                                                                                                      |
| Share of global copper reserves                    | 0.05 % ( <i>USGS estimate global Cu reserves of 890 Mt</i> )                                                                                                                                                          |
| JORC compliant resources                           | 25.7 Mt @ 1.125 % Cu, 19.997 g/t Ag                                                                                                                                                                                   |
| Share of global copper resources                   | 0.01 % ( <i>USGS estimate global Cu resources of 2100 Mt</i> )                                                                                                                                                        |
| Waste to ore ratio (whole orebody)                 | 6.2 for 49.6 Mt                                                                                                                                                                                                       |
| Annual production                                  | 3.2 Mt of ore, 30 kt of contained Cu, 1.2 Moz of contained Ag<br>Planned: 5.2 Mt of ore, 50 kt of contained Cu                                                                                                        |
| Life of mine                                       | 10 years (post-expansion for the 5.2 Mt/a production)                                                                                                                                                                 |
| Investment required                                | US\$ 499m (refers to entire CAPEX, which includes already invested US\$ 185.4m as well as US\$ 140m approved credit).<br>US\$ 72m are required for the A4 open pit and processing plant expansion to 5.2 Mt of ore/a. |
| Net present value (NPV)                            | US\$ 548m (based on 7 % discount rate, and copper and silver priced of US\$ 7,872/t and US\$ 20/oz, respectively)                                                                                                     |
| Share of global copper production (post expansion) | 0.23 % (considering 50 kt Cu/a, recovery 92.2 %)<br>( <i>USGS estimate global Cu production of 22 Mt</i> )                                                                                                            |

#### Mining and processing:

- Conventional open pit methods employing drilling, blasting, and hauling (on the T3 and potentially A4 open pits). The mining plan envisages an ore production rate of 5.2 Mt/a (after expansion) with a medium average waste to ore ratio of 6.2 (for 49.6 Mt of reserves). The waste to ore ratio will increase as mining progresses into the deeper parts of the ore body. Sandfire has contracted the company African Mining Services for open pit mining services.

- Copper and silver are concentrated via crushing, milling, classification and flotation resulting in an average final concentrate grade of 30 % Cu and 380 g/t Ag. Copper and silver recoveries yield average values of 92.2 % and 87.4 %, respectively.
- The copper cut-off grade is variable, based on silver credits, contaminant penalties and variable metal recovery dependent on head grades for copper, silver, sulphur, arsenic, lead, zinc and the ratio of copper to acid soluble copper.
- The average operating cash cost over the life-of-mine consists of US\$ 1,852/t copper mining costs, US\$ 1,235/t copper processing cost inclusive of power, site administration and offsite logistics costs of US\$ 507/t copper, US\$ 419/t copper treatment and refining charges, and a silver by-product credit of US\$ 772/t copper, and sums up to 3,241 US\$/t of copper.

### **BGR assessment and comments:**

- The initial development is expected to generate approximately 1,000 jobs during the construction phase and 600 direct full-time jobs during operations, with at least 95 % of the total mine workforce expected to be made of up of Botswana citizens. In addition to direct employment, the mine is also forecast to generate an estimated 1,500 indirect jobs, with local businesses to supply provisions, parts, services and support throughout construction and operation.
- The life of mine has been considered 10 years, however, there is potential for further resource and reserve growth, with drilling continuing across Sandfire's target pipeline within an extensive landholding in the Kalahari Copper Belt (>25,000 km<sup>2</sup> in Botswana and Namibia).
- Sandfire assumes long-term copper and silver prices of US\$ 7,872/t and US\$ 20/oz, respectively, which are both similar to average prices over the past 5 years and might be estimated slightly higher due to recent increases of the individual prices.
- 

### **4.18.3 ESG assessment**

The level of publicly available information on the Tshukudu project is in general good, but missing some specific information. Based on available information no major ESG issues were identified. Sandfire's corporate policies, management systems, and global track record suggest good risk management, though data for Tshukudu is not yet available.

| ESG issue                                                          | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Environmental Management                                           | No reports on incidents found company-wide. Environmental policy in place; environmental management at Australian assets is described as exemplary, but limited information for Botswana available.                                                                                                                                                                                                                                     |
| Efficient use of energy, renewable energy, GHG emissions reporting | No information on specific energy use for operational phase available. Electrical power from grid (fossil fuel based); planning of photovoltaic energy and battery storage plant ongoing (~1/3 of project energy needs). Company-wide commitment to reach 50 % renewable energy by 2030 and net zero by 2050. Scope 1 and 2 emissions will be calculated based on the Australian NGER Act; Scope 3 assessment framework in development. |
| Water management and consumption                                   | No information on specific water use for operational phase available. Project located in arid area with low water use. Water will be sourced from groundwater; hydrological models developed to determine the regional impact of the project. Establishment of local committee overseeing groundwater usage. Low to medium riverine flood risk.                                                                                         |
| Pollution prevention                                               | General risk of acid mine drainage due to sulphide deposits, adequate tailings and mine waste management required; though this is considered lower in arid areas. Flotation technology may imply use of hazardous reagents.                                                                                                                                                                                                             |
| Air quality                                                        | Site location remote, does not indicate general need for special measures.                                                                                                                                                                                                                                                                                                                                                              |
| Tailings management                                                | Sandfire states that implementation of the Global Industry Standard for Tailings Management is planned; tailings facilities shall be subject to independent geotechnical review on an annual basis.                                                                                                                                                                                                                                     |
| Waste management                                                   | AMD potential of waste rock is lower risk due to arid climate, however adequate measures are recommended. Sandfire is committed to improve plant waste management by setting up collection points in the surrounding villages.                                                                                                                                                                                                          |
| Hazardous materials management                                     | Flotation and use of required reagents is considered low risk assuming responsible handling; specific information was not available.                                                                                                                                                                                                                                                                                                    |
| Noise and vibration                                                | Conventional drilling and blasting operation; no nearby settlements that could be negatively affected.                                                                                                                                                                                                                                                                                                                                  |
| Protected areas and biodiversity                                   | The project is not located in or close to a key biodiversity area or other designated protected area. Development of Biodiversity Management Plan for every project site; the plan was not publicly available for review.                                                                                                                                                                                                               |
| Mine closure                                                       | Company states that mine closure plan (updated every three years) includes sufficient financial reserves (reviewed every six month) and consideration of possible impacts of climate change; the plan was not publicly available for review.                                                                                                                                                                                            |
| <b>Social and socio-economic issues</b>                            |                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Community health, safety and security                              | Scarcely populated area; Mine site around 80 km northeast of the town of Ghanzi (~21,400 inhabitants, ~6,900 in the surrounding towns); distance to settlements large enough that the potential negative impact on the local population is considered low. Ecosystem service assessment examined impact on traditional San people.                                                                                                      |

| ESG issue                                                 | Assessment                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dialogue and engagement with communities and stakeholders | Sandfire develops Stakeholder Engagement Plan and Community Investment Plan to identify stakeholders and key community investment areas. Dialogue with San people through traditional decision-making forum.                                                                                                                                                |
| Land acquisition and involuntary resettlement             | Requirement of resettlement of local farmers might be necessary. Resettlement Action Plan in accordance with IFC Performance Standard 5 and 7 for affected parties; development of compensation framework in consultation with key stakeholders. Census on farmer households to examine use of natural resources and maintaining access at relocation area. |
| Occupational health & safety management (OHS)             | ISO 45001 OHS Management and ISO 31000 Risk Management in place; Total Recordable Injury Frequency Rate (TRIFR) 1.3 (3.8 companywide). Qualified personnel undertaking relevant health and wellbeing services at all operations available; organising Botswana Health and Wellness Day.                                                                     |
| Workers' rights                                           | Botswana scores 42/100 in the Labour Rights Index. Yearly employee surveys; implementation of Sandfire's Employee Assistance Program in Botswana will be considered for operational phase.                                                                                                                                                                  |
| Gender and diversity                                      | 24 % female employees (23 % company-wide); discrimination reporting portal managed by third party is in place.                                                                                                                                                                                                                                              |
| Local value added and community                           | Sandfire aiming at a high percentage of national employees and local procurement and estimated ~2,000 direct and indirect jobs to be created. US\$ 207,351 for community investment including drinking water supply, community gardens, Youth Development Program.                                                                                          |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                             |
| Legal compliance                                          | No indication of any breaches of law found. Environmental baseline studies completed; working on Environmental Social and Impact Assessment.                                                                                                                                                                                                                |
| Management practices                                      | Management framework in accordance with the ASX Corporate Governance Council's Corporate Governance Principles and Recommendations. Relevant management policies in place and publicly available.                                                                                                                                                           |
| Transparency and reporting                                | Listed on the ASX; information for investors, reports on financial accounts and shareholder structure available. Adopted reporting frameworks: IFC performance standards, GRI standards, TCFD recommendations, SASB.                                                                                                                                        |
| Business ethics                                           | Botswana scores 59/100 in the corruption perception index; Botswana is not an EITI country; no indication of unethical practices found. Sandfire intensified anti-bribery and corruption due diligence due to international expansion of the company. Sustainable Procurement Standard for Botswana in place.                                               |

Table 50. ESG features of Motheo project, Botswana



#### 4.18.4 Infrastructure assessment

##### Potential Investment Needs:

- **Railway Enhancements:** Funding of US\$ 9.5b Trans-Kalahari Railway Project (tendering process expired but not yet awarded).
- **Renewable Energy Ventures:** Investment opportunities to increase energy supply via photovoltaic plants and decrease dependencies on national grid powered by fossil fuels.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | Motheo is a greenfield project. The proposed T3 mine site is located on freehold farmland 153-NL situated on Prospecting Licence (PL) 190/2008. Tshukudu Metals Botswana (Pty) Ltd (Tshukudu Metals), a wholly owned subsidiary of Sandfire, has a binding agreement with the farmer to acquire approximately 50 % of Farm 153-NL, which will include the full ~25 km <sup>2</sup> area on which the Motheo project is located. The land transfer process to Tshukudu Metals is in its final stages. PL 190/2008 also includes the A4 deposit and forms part of the regionally extensive Kalahari Copper Belt.                                                                                                                                                                                                                                                                             |
| Transport                 | The Motheo copper project is located 270 km northeast of Ghanzi and is accessible by road via the A3 highway (220 km) and the Old Ghanzi Road (14 km). The 14 km access road is a two-way, 10 m wide carriageway of gravel construction, utilising locally won calcrete for pavement. The calcrete was sourced from the pre-stripping phase of the mine development. The road is fenced on both sides with gates installed at locations that allow farmers access for movement of livestock.                                                                                                                                                                                                                                                                                                                                                                                               |
| Airport                   | Ghanzi Airport is located approximately 1 km from the centre of Ghanzi township. There is currently no scheduled service, but only charter and private operations. In terms of passenger and aircraft movements, the current Ghanzi Airport can be classified as a marginal airport. However, despite negligible traffic demand, the airport has been declared port of entry. The airport has a bitumen sealed 1.5 km long and 18 m wide runway (designation: 06/24) and is designed to handle light aircraft with Maximum All Up Weight (MAUW) of 5.7 t. Okwa Camp One Airport is another near-lying airport to Sandfire's Motheo operation, situated approximately 182 km via the A2 highway.                                                                                                                                                                                            |
| Rail access               | Domestic infrastructure consists of a single 886 km railway line from Lobatse and Gaborone City in the south to Francistown in the north. The US\$ 9.5b Trans-Kalahari Railway Line project is currently under tender and comprises approximately 1,500 km of rail infrastructure expansion, with a larger portion of it in Botswana from Mmamabula to its final destination in Walvis Bay, Namibia. The railway serves as a strategic project that will enable seamless movement of goods and people between the two countries, whilst furthermore connecting the landlocked nation with ports on the continent's west coast. Fuel, coal, and copper are among goods that will be transported via the railway line. The railway line, which will be integrated into existing railways in Botswana and Namibia, will pass through Molepolole, Letlhakeng, Charleshill, enroute to Gobabis. |
| Port                      | High-quality copper concentrate (containing a silver by-product) is transported by truck to Walvis Bay, Namibia, for shipping to smelters around the world. The Port Walvis Bay is managed by Namport and is Namibia's largest commercial port, receiving approximately 3,000 vessel calls each year and handling about 5 million t of cargo. The port handles                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | container imports, exports, and transhipments, as well as bulk and break-bulk of various commodities. The entrance channel has a length of 5.2 nautical miles, a width 134 m, and a depth -14 m chart datum. Ships can anchor within port limits and are protected by the bay.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Energy       | The T3 Motheo Project has an initial maximum power demand of approximately 13 MW. Power for the project will be via a grid connection with the Botswana Power Corporation. A new switching station will be constructed at the intersection of the A3 Highway and the site access road for the connection to the Botswanan grid. From here, a 14 km-long 132 kV overhead transmission line will run to the substation adjacent to the processing plant. The sub-station will be equipped with two 132/11 kV stepdown transformers, each of 25 MVA capacity and associated switchgear to supply 11 kV of power to the project. Sandfire will execute a power supply agreement with Botswana Power Corporation with the tariffs applicable to the project being gazetted by the Botswana Government. The Company is in the advanced planning stage of the installation of a 22 MWp photovoltaic plant in combination with a battery energy storage system. The photovoltaic plant is expected to meet up to 34 % of the project's energy requirements. |
| GHG emission | Responding to climate change remains one of the six pillars in Sandfire's ESG framework. Implementing photovoltaic plants will decrease GHG emissions. The local conditions (Direct Normal Irradiation equivalent of 3,000 kWh/m <sup>2</sup> /a in most parts of the country) are suitable for further expanding the solar energy supply via photovoltaic, which is the most utilised renewable energy source in Botswana. Geographical conditions do not hinder the construction/expansion of the photovoltaic plant.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Water        | The project infrastructure includes surface water diversion channels and dewatering bores. Raw water for the plant will be sourced from pit dewatering bores. The water will be pumped to the dewatering transfer pond located adjacent to the open pit and from there to the raw water pond located in the process plant. The bores supplying the raw water will form part of the open pit dewatering network of bores located around the pit. Dewatering bores in the early years will produce more water than the process plant requires with excess clean water being recharged to the aquifer or distributed to the local farming community as replacement clean water supplies.                                                                                                                                                                                                                                                                                                                                                               |

**Table 51. Infrastructure assessment of Motheo project, Botswana**

#### 4.18.5 Further reading

Metal Tiger Plc. (2022) Annual Report & Accounts 2022.

[https://www.annualreports.com/HostedData/AnnualReports/PDF/LSE\\_MTR\\_2022.pdf](https://www.annualreports.com/HostedData/AnnualReports/PDF/LSE_MTR_2022.pdf) (accessed 14.06.23)

Sandfire Resources Ltd. (2020): Sandfire approves development of new long-life copper mine in Botswana. <https://sfr.live.irmau.com/site/pdf/02f6e6a8-28a4-432d-9bec-e068b99608c6/Sandfire-Approves-Development-of-new-Longlife-Copper-Mine.pdf> (accessed 15.06.23)

Sandfire Resources Ltd. (2021): Maiden Ore Reserve for A4 Deposit and PFS confirms 5.2Mtpa Motheo Copper Project.

<https://announcements.asx.com.au/asxpdf/20210922/pdf/450qy4z29r2zl8.pdf> (accessed 14.06.23)

Sandfire Resources Ltd. (2022a): Motheo Copper Project Expansion DFS.

<https://announcements.asx.com.au/asxpdf/20220830/pdf/45dg6c6350pvvh.pdf> (accessed 15.06.23)

Sandfire Resources Ltd. (2022b): 2022 Sustainability Report.

<https://staging.sandfire.com.au/wp-content/uploads/2022/10/Sandfire-Sustainability-Report-2022-Spreads.pdf> (accessed 14.07.23)

Sandfire Resources Ltd. (2023): First Concentrate Produced at Motheo.

<https://announcements.asx.com.au/asxpdf/20230525/pdf/05q0kqk9ml6l8t.pdf> (accessed 14.06.23)

## 4.19 Musha-Ntunga Sn (-Ta-Li) pegmatite project (Rwanda)

Information as of 10/2023

### 4.19.1 General project background

|                                    |                                                                                                                                                                                                                                 |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>           | Tin                                                                                                                                                                                                                             |
| <b>Other commodities</b>           | Tantalum, lithium (potentially)                                                                                                                                                                                                 |
| <b>Location</b>                    | Rwamangana District, Eastern Province, Rwanda<br>01°55' S and 30°20' E, 1,640 m.a.s.l.                                                                                                                                          |
| <b>License type</b>                | 0252/MINIRENA/2014 (valid until 24.08.2039)                                                                                                                                                                                     |
| <b>License owner / operator</b>    | Piran Rwanda Ltd. (owned by Trinity Metals Group)                                                                                                                                                                               |
| <b>Contact</b>                     | Trinity Metals Group                                                                                                                                                                                                            |
| Direct contact established: Yes    | Masoro, Rulindo, P.O Box: 6132 Kigali-Rwanda<br>+250 791 959 034<br><a href="https://trinity-metals.com">https://trinity-metals.com</a><br><a href="mailto:peter.geleta@trinity-metals.com">peter.geleta@trinity-metals.com</a> |
| <b>Project status</b>              | Mining                                                                                                                                                                                                                          |
| <b>Possible production by 2030</b> | Yes (already producing at small scale)                                                                                                                                                                                          |

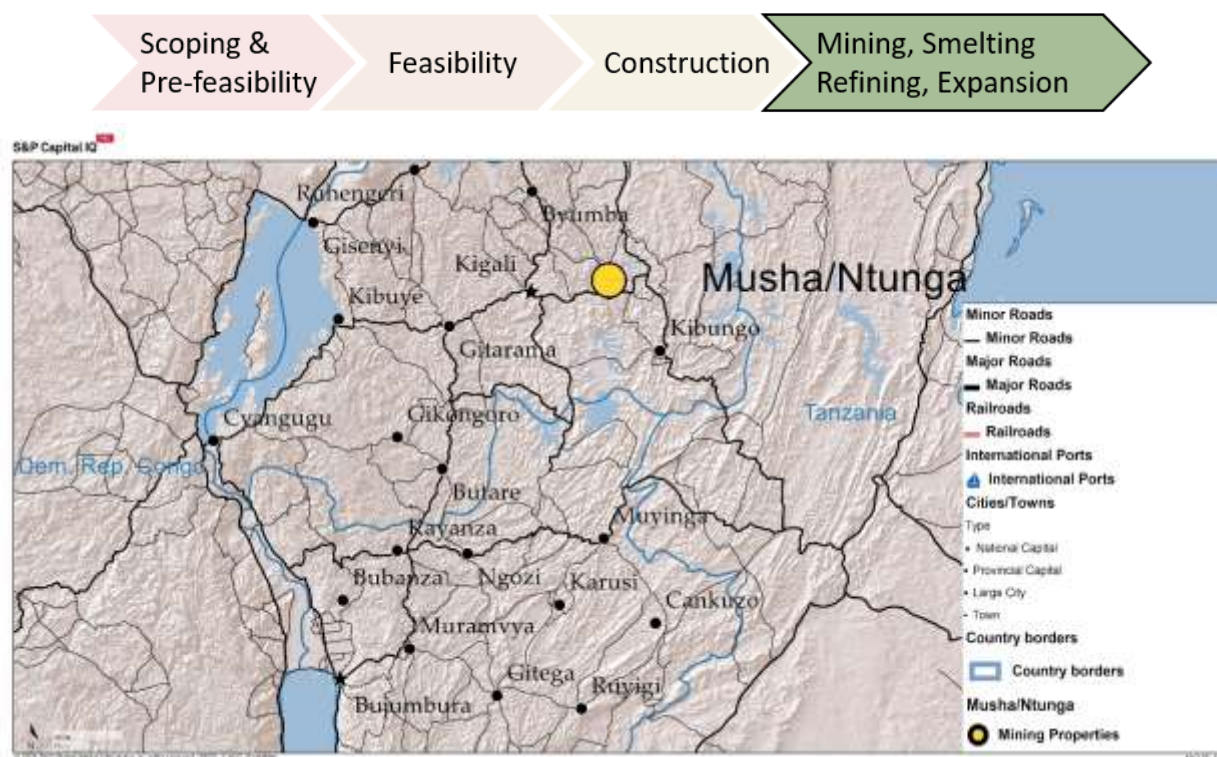


Figure 38. Musha-Ntunga location, Rwanda

### 4.19.2 Economic assessment

#### General project background:

The Musha mine, with a number of satellite mines, is part of the Ntunga concession and situated 45 km from Kigali in the Eastern Province. The owner of Musha mine, Trinity Metals Limited, owns a 25-year mining license starting from 2014. The operation currently produces 20 t of cassiterite concentrate containing 70 % tin per month and small quantities of coltan (Ta-Nb). The polymetallic 9,000 t Sn-Ta resource (defined in 2018) also has a high-grade lithium (1.5 % Li<sub>2</sub>O) potential at the Musha-Ntunga pegmatite. The lithium zone of the pegmatite is currently in the exploration phase to delineate assess, scale and extraction options. The company is confident in advancing the project into a full feasibility phase for a globally significant Li-Sn-Ta resource. Trinity Metals intends to invest over US\$ 60m in its existing projects Nyakabingo, Rutongo (tin) and Musha (tin, tantalum and lithium) over the next three to five years, with a focus on efficiency and modernization of operations. Currently, the company has been using the small upgrading plant units, and has a plan to construct big processing plants at the mine sites as the mining operations are being extended. The company also owns the Rutongo tin mine and the Nyakabingo tungsten mine.

#### Project description:

|                                    |                                                                                                                                                                                                                              |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Sn(-Ta-Li)-bearing quartz veins and pegmatite intrusions                                                                                                                                                                     |
| JORC compliant resources           | Musha mine: 0.5 Mt @ 1.2 % Sn eq.                                                                                                                                                                                            |
| JORC compliant resources           | Musha-Ntunga pegmatite: 9.2 Mt @ 0.25 % Sn eq. (plus Li potential)                                                                                                                                                           |
| Share of global tin resources      | 0.6 % ( <i>USGS estimate global Sn resources of 4.6 Mt</i> )                                                                                                                                                                 |
| Waste to ore ratio (whole orebody) | Unknown at Musha mine, probably low because of the underground selective mining method used; open pit mining at the Musga-Ntunga pegmatite might cause increased waste-to-ore ratios but the mine plan is not yet elaborated |
| Annual production                  | Current output abt. 170-240 t of Sn; expected output in 2028 about 500 t of Sn in concentrates                                                                                                                               |
| Life of mine                       | A static lifetime of 15 to 20 years                                                                                                                                                                                          |
| Investment required                | About US\$ 14-22m to be spent in a period of five years for modernisation and additional processing capacity                                                                                                                 |
| Net present value (NPV)            | Not yet defined.                                                                                                                                                                                                             |
| Share of global tin production     | 0.08 % ( <i>USGS estimates global Sn production of 317 kt in 2022</i> )                                                                                                                                                      |
| Value addition potential           | Refining of tin concentrates could take place in Rwanda at the LUNA Smelter close to Kigali. Lithium ore could be concentrated in a mineral processing plant.                                                                |

#### Mining and processing:

- Main commodities at the Musha and Ntunga concession have been cassiterite and tantalite. Historical production from colonial era operations and artisanal miners is estimated at >20,000 t Sn. Shallow underground mining at Musha is based on vein deposits hosting coarse-

grained cassiterite, whereas at the Ntunga pegmatite the mineralisation (<1 m to >30 m width) is hosted in highly kaolinised Sn-Ta pegmatites

- At the Musha mine, access is provided by tunnels, which connect cross-cuts and internal shafts that provide access to the various stopes. Ore is extracted manually using jackhammers. Transport inside the tunnels is done by wheelbarrows, while transport of ore to the upgrading stations is done by trucks. To increase hoisting between the levels, small electric winches are installed. As a supplement for the natural ventilation of the mine small electric blower fans are installed in the galleries in the vicinity of the stopes.
- At the Ntunga mine access to the weathered pegmatite is provided by a box cut. The ore containing sections of the pegmatite are excavated by manual digging using jackhammers.
- The run of mine ore is upgraded by handpicking and then crushed. The crushed ore is washed and then sorted by gravitation in sluices and shaking tables to obtain pre-concentrates. After drying, the coltan minerals are separated from the cassiterite minerals by magnetic separation. The final products are saleable concentrates of coltan and tin.
- At Ntunga, indications show that spodumene is the dominant lithium mineral. Currently, there is not yet a design concept elaborated for the possible production of Li-products.

#### **BGR assessment and comments:**

- The Musha deposit would be the base for a high-grade, low-tonnage underground operation. The relatively long life of mine (at minimum 15 years) is considered as positive for the development of the region. Resource expansions are possible due to the potential vertical extension of the deposit.
- In contrast to Musha, the Ntunga mineralisation is relatively shallow and of low grade (about 0.25 % Sn eq.), requiring a high-tonnage open pit operation. Assuming a production rate of 0.5 Mt/a over a life of mine of 18 years, the annual metal output from the pegmatite ore body would correspond to 1250 t Sn eq. At deeper levels, mining and processing of lithium ore could become a relevant factor, since in the exploration phase, unweathered pegmatite ore with high-grade lithium containing intersects such as 79.5 m @ 1.59 % Li<sub>2</sub>O were discovered.
- Gravity sorting of Musha-Ntunga ore is well known and poses no technical risk. The production of Li-concentrates would be a new business field for Trinity and could be challenging.
- The project is located ~45 km (via paved road) from the capital Kigali. The export of concentrates would be done in containers by paved road to the ports of Dar Es Salam or Mombasa. The transport distance by truck is about 1,500 km.



### 4.19.3 ESG assessment

The level of publicly available project information is limited because of the early project stage. However, Musha is a brownfield project with a production history dating back to the 1920s. Therefore, the general mining impacts are well known. Under the former ownership, the Ntunga mine had some geotechnical stability issues in the open pit that seemed to be resolved by the new mine management.

According to Trinity the company complies with guidelines and standards from leading local and international bodies such as the local Certified Trading Chain (CTC) standard and the OECD standards. A code of conduct as well as relevant policies and standards to ensure ethical business conduct and responsible practices pertaining to human rights, labour rights and the environment are available, information on practical implementation should be an issue of further assessment.

The company claims that more than 99 % of employees are local workforce and 70 % of the materials used in the operation are procured locally.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                |
| Environmental Management                                           | Company policies includes commitment to establish and implement an environmental management system addressing risks and impacts to the environment as well as environmental reporting and target setting.                                                                                                                                                      |
| Efficient use of energy, renewable energy, GHG emissions reporting | There are plans to reduce and offset carbon emissions and utilize eco-conscious mining methods and technology. Trinity Metals has planted more than 657,000 trees across the three mine sites. According to IRENA Rwanda's electricity mix has around 50 % renewables (2022).                                                                                  |
| Water management and consumption                                   | Over 90 % of the water used is recycled and no process water is discharged. Water from the tailings storage facility is managed in a closed-circuit operation. The overall annual water stress at the mining sites is considered as low. Extremely high riverine flood risk.                                                                                   |
| Pollution prevention                                               | Trinity Metals intends to prevent pollution and avoid or minimize waste generation by actively promoting reuse, recycling, and resource efficiency.                                                                                                                                                                                                            |
| Air quality                                                        | Scarcely populated area, and OHS management in the mine and at the processing site is in place, considered low risk.                                                                                                                                                                                                                                           |
| Tailings management                                                | The currently low production rate of about 1,500 t ore/month requires only a small-sized TSF. The mine tailings are chemically inert; therefore, no lining of the TSF is required. When the production is increased and the processing of Li-ores takes place, probably a new tailings pond has to be constructed applying state of the art design guidelines. |
| Waste management                                                   | Unknown. Low at Musha, due to underground mining.                                                                                                                                                                                                                                                                                                              |
| Hazardous materials management                                     | No hazardous materials are used in mineral beneficiation and in consequence, the risk of tailings is considered low.                                                                                                                                                                                                                                           |
| Noise and vibration                                                | OHS management is in place at Musha. Mine is located in a scarcely populated area, therefore the risk is considered low.                                                                                                                                                                                                                                       |



| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Protected areas and biodiversity                          | Project not located in or close to a key biodiversity area. Expected biodiversity impacts are low. According to the environmental policy, Trinity intends to protect and conserve biodiversity, fauna, and flora as far as possible and aim for zero impact on the areas in which they operate.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Mine closure                                              | According to company policy a plan for the eventual closure of mining operations, including management of social and environmental impacts, estimates of closure costs, and financial provisions has to be maintained and updated.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Community, health, safety, and security                   | Trinity Metals claims that it has developed a social risk management framework to capture all social risks and opportunities that is periodically updated, identifies all hazards, and assesses the associated risks while taking appropriate actions to manage these risks as well as incidents. According to the Global Human Settlement classification, Musha can be categorized as low density rural grid cell and Ntunga as dense or semi-dense urban cluster. The closest distance between the mining sites and the farm houses at Musha and Ntunga is about 200 m.                                                                                                                                                                                                                                                                                 |
| Dialogue and engagement with communities and stakeholders | Trinity Metals policy requires engaging regularly with all relevant stakeholders, including host communities and local government institutions, through appropriate channels. The company is investing in community-based mining cooperatives in coordination with the Rwanda Mines, Petroleum and Gas Board (RMB). Trinity claims that it works with the authorized regulatory authorities to provide community-based miners with the training, tools, and infrastructure required to operate safely and legally. There is no information available for a structured dialogue with communities.                                                                                                                                                                                                                                                          |
| Land acquisition and involuntary resettlement             | Trinity's social performance policy claims to avoid physical and economic displacement of host communities and, where unavoidable, follows a proper consultation process with affected communities; they claim to follow legal provisions for expropriation and fair and timely compensation. Policies include Human Rights Policy, Social Performance Policy and Code of Conduct. Close to the concession there is no world heritage site registered by UNESCO.                                                                                                                                                                                                                                                                                                                                                                                          |
| Occupational health & safety management (OHS)             | According to its OHS policy, Trinity Metals and its affiliated companies are committed to identifying all hazards and assessing the associated risks while taking appropriate action to manage these risks, investigate and act on all health and safety incidents, to adopt a culture of caring and an awareness of each other's safety and Health, to engage all employees and key stakeholders to implement an effective and sustainable health and safety management system, to take personal and collective responsibility for its health and safety performance and to ensure continuous improvement in managing its health and safety performance by setting clear objectives and measurable targets. There exist an OHS-policy. The ASM underground mining activities require safety measures that are appropriated to small-scale mining issues. |

| ESG category                                | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Workers' rights                             | According to the human rights policy of Trinity, the company is not certified by ISO norms or ILO conventions but is following a multitude of guidelines to secure safety & health, fair remuneration (including stakeholders), continuous training for their employees, and reviews business practices of their business partners. Trinity tries to prevent, mitigate, and, where appropriate, remedy any human rights impact that they may have caused or contributed to and take appropriate action where they identify violations of this Policy by employees or business partners, including termination of employment or contract and referral to the relevant authorities and publicly communicate their human rights management approach and performance in their annual reporting. The 2022 labour right score of Rwanda is 63.5 that indicates a limited access to decent work.                                                                                                                      |
| Gender and diversity                        | According to the human rights policy of Trinity, the company intends to foster an environment that promotes diversity and inclusion. one woman out of 8 board directors, 2 women out of 12 executive management team;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Local value added and community development | According to the social performance policy of Trinity, the company complies with all applicable laws, regulations, procedures, and license or agreement obligations for all its member companies/subsidiaries. They claim that this includes a social risk framework and risk assessment to ensure that affected communities are proactively engaged in matters that affect them. They want to create benefits for host communities by prioritizing local content support in the form of employment, procurement, and investing in social development projects. The total number of workforce for all three mines of Trinity Metals in Rwanda is abt. 4800 miners. 99 % of the workforce is of Rwandan origin. The company is investing in community-based mining cooperatives in coordination with Rwanda Mines Petroleum and Gas board (RMB) and works with the regulatory authorities to provide community-based miners with the training, tools and infrastructure required to operate safely and legally. |
| <b>Governance</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Legal compliance                            | Relevant mining and environmental licences are available. No indication of any violation of the law found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Management practices                        | Trinity Metals has adopted relevant policies related to international ESG requirements in its code of conduct; policies and standards are laid out for: anti bribery and corruption, OHS, social performance, whistleblowing, human rights and environment. Information on related certifications not available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Transparency and reporting                  | The Company claims that it abides by the principles set out in the 2016 OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from conflict-affected and high-risk Areas. The company is audited by the Rwanda Mines Petroleum and Gas board (RMB) according to the Regional Certification Mechanism (RCM) standard. However, there is no information about independently conducted 3 <sup>rd</sup> -party audits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Business ethics                             | The Ireland based company Techmet is Trinity Metals' majority shareholder. Techmet works with a number of investment partners including the US                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| ESG category | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | Development Finance Corporation (DFC) to fund its portfolio. Additional shareholders include Piran Resources, the parent company of Piran Rwanda Limited and the Rwandan Government, represented by Ngali Holdings Limited. The company Trinity Metals uses a Code of Conduct that sets out the required principles and standards with which the Board, Management, and Employees of the Company must comply when conducting company business and dealing with each other, the shareholders, stakeholders, and the broader community. No policy related to supply chain DD published (as per OECD requirement), the company states certification of minerals as “conflict-free” as well as full traceability. There is an anti-corruption and bribery, and whistle-blowing policies. Rwanda is not part of the EU CAHRA list, though may be considered a red-flag location due to mineral smuggling risks. Rwanda ranks 49/180 in the Corruption Perception Index (ranking 3 <sup>rd</sup> best in Africa). Rwanda is not an EITI country. |

Table 52. ESG features of the Musha project, Rwanda

#### 4.19.4 Further reading

Trinity Metals Ltd. (2023): <https://trinity-metals.com/home/sustainability/> (accessed 16.10.23)

## 4.20 Mutoshi sediment-hosted Cu-Co project (DR Congo)

Information as of 12/2023

### 4.20.1 General project background

|                                 |                                                                                                                                                                                                      |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Copper, cobalt                                                                                                                                                                                       |
| <b>Location</b>                 | Lualaba, Dem. Rep. Congo<br>10°41' S, 25°32' E, 1400 – 1550 m.a.s.l.                                                                                                                                 |
| <b>License type</b>             | Mining licenses PE2604 Mutoshi, PE2756 Kulumaziba                                                                                                                                                    |
| <b>License owner / operator</b> | Gécamines (DRC gov.) is the owner of the concessions, Chemaf Resources Ltd. (private company) has a lease agreement (2015-2040) for mining and processing                                            |
| <b>Contact</b>                  | 30th Floor, Almas Tower, Jumeirah Lake Towers,<br>Dubai, United Arab Emirates<br><a href="https://www.chemaf.com">https://www.chemaf.com</a><br><a href="mailto:info@chemaf.com">info@chemaf.com</a> |
| <b>Project status</b>           | Preproduction - Construction Started                                                                                                                                                                 |
| <b>Production by 2030</b>       | Yes                                                                                                                                                                                                  |

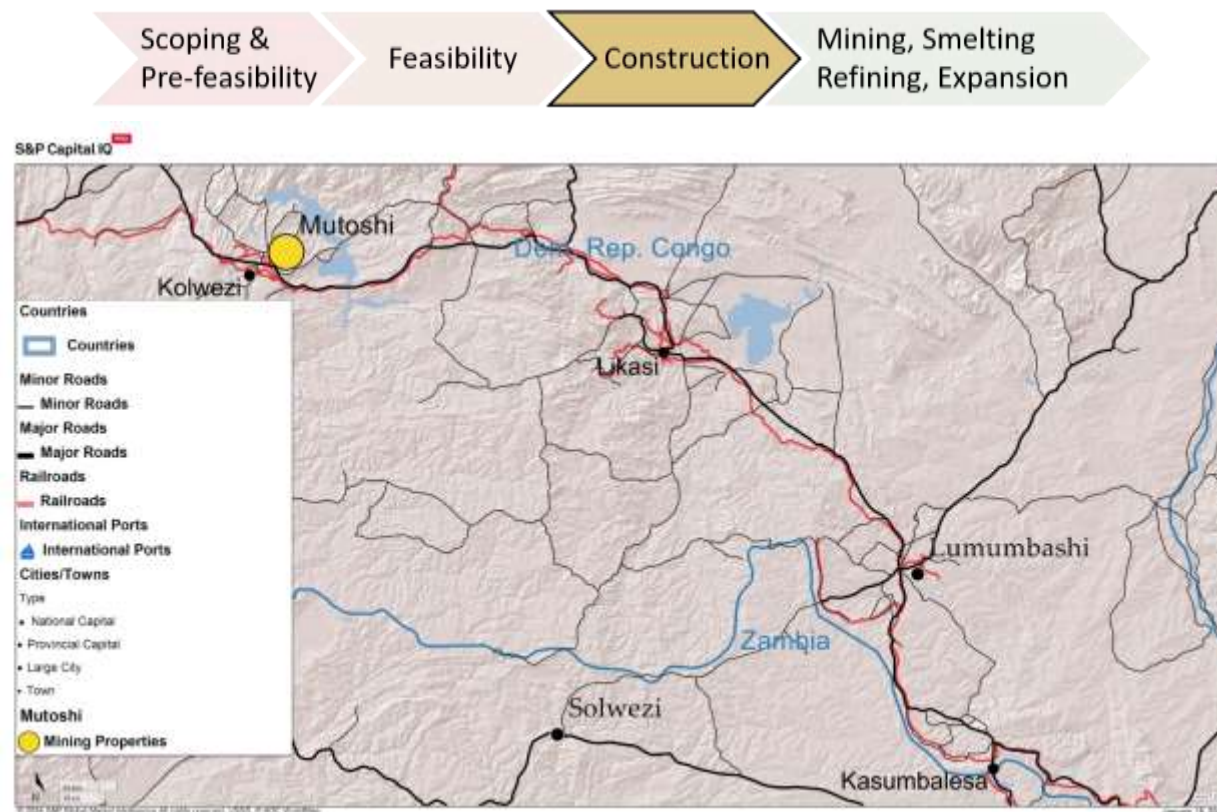


Figure 39. Mutoshi project location, DR Congo

### 4.20.2 Economic assessment

#### General project background:

The Mutoshi project is located at the north-eastern outskirts of the city of Kolwezi. Initially, exploited for gold (from 1903), Mutoshi's copper-cobalt ore bodies were first drilled in the early 1920's and initially mined between 1937 and 1987. Stratiform, sediment-hosted copper-cobalt mineralisation is hosted in two ore beds separated by a layer of siliceous dolomite. The mineralisation is present in the form of sulphides and in overlying supergene oxide ore. Mutoshi comprises several different orebodies, namely the historical Kulumaziba tailings, the Kumwehulu orebody, and the Mutoshi North and Mutoshi Central orebodies. For more than a decade, several thousand artisanal cobalt miners have been active in some parts of the concession, tolerated by the provincial government. During certain periods, Chemaf, the current operator, was involved in the supervision of these activities and purchased the artisanal ore production. Focusing on oxide mineralisation, the construction of industrial mining and processing facilities began in 2018, but has not yet been completed. By Q3/2023, Chemaf had spent about US\$ 570m for the development of Mutoshi and, on another concession, the expansion of its Etoile copper-cobalt mine, with financing raised through banks and an offtake partner. However, Chemaf then announced that it would require a further US\$ 300m financing (equity and debt) to close a funding gap, complete the construction of Mutoshi and Etoile, and restructure existing debt.

#### Project description:

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Stratiform, sediment-hosted copper deposit                                                                                                                                                                                                                                                                                                                                                                                                  |
| Resources (unknown code)           | 160 Mt @ 0.84 % Cu, 0.25 % Co                                                                                                                                                                                                                                                                                                                                                                                                               |
| Share of global copper resources   | 0.1 % ( <i>USGS estimate global Cu resources of 2,100 Mt</i> )                                                                                                                                                                                                                                                                                                                                                                              |
| Share of global cobalt resources   | 1.6 % ( <i>USGS estimate global Co resources of 25 Mt</i> )                                                                                                                                                                                                                                                                                                                                                                                 |
| Waste to ore ratio (whole orebody) | Not published, but expected to be low due to surface operation                                                                                                                                                                                                                                                                                                                                                                              |
| Annual production                  | 3.9 Mt of ore, 50 kt of copper cathodes, 16 kt of cobalt contained in cobalt hydroxide (see BGR assessment below)                                                                                                                                                                                                                                                                                                                           |
| Life of mine                       | >30 years                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Investment required                | US\$ 300m (refers to completing the Mutoshi mine construction and Etoile mine expansion)                                                                                                                                                                                                                                                                                                                                                    |
| Net present value (NPV)            | Not published                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Share of global copper production  | 0.2 % (recovery not published)<br>( <i>USGS estimate global Cu production of 22 Mt</i> )                                                                                                                                                                                                                                                                                                                                                    |
| Share of global cobalt production  | 8.4 % (recovery not published)<br>( <i>USGS estimate global Co production of 190 kt</i> )                                                                                                                                                                                                                                                                                                                                                   |
| Value addition potential           | During early project development, Chemaf discussed options with external service providers for expanding the value chain from cobalt hydroxide to refined cobalt sulphate. While this plan was dropped, it may still be considered of interest when considering the development of a DRC-hosted Special Economic Zone on battery value chains. Semi-formalised artisanal cobalt ore production at Mutoshi contributed to the local economy. |

**Mining and processing:**

- Conventional open pit methods planned, employing drilling, blasting, and hauling of oxide ore while also re-mining of historical tailings, envisaging an ore production rate of 3.9 Mt/a. The ore from different ore bodies is heterogeneous; hence, metallurgical processing may be complex.
- The crushed and milled ore feed shall be subjected to leaching, counter-current decantation and solvent extraction. Copper is recovered via electro-winning (cathodes >99.99 % purity) and cobalt as crude cobalt hydroxide (cobalt grade of ~30 % in DRC Copperbelt mines).
- In 2015, Chemaf signed a 25-year lease agreement with Gecamines (DRC gov., owner of the concessions) for the mining and processing of Mutoshi's copper-cobalt ore. In addition to reinvesting its own mining profits, Chemaf transferred the marketing rights for its entire DRC cobalt hydroxide production to Trafigura and received US\$ 600m in financing to complete the construction of the Mutoshi mine and other Chemaf facilities in the DRC. In 10/2023, Chemaf announced that it would seek offers for a full takeover of the company due to debt totalling US\$ 690m and another US\$ 300m required to finish Etoile expansion and Mutoshi construction.

**BGR assessment and comments:**

- The deposit is an intermediate-grade, high-tonnage surface operation with an expected relatively low waste to ore ratio and an expected long life of mine (>30 years). Chemaf plans to operate the plant with an annual throughput of 3.9 Mt of ore. At a typical cobalt recovery rate from ore to hydroxide for this type of operation of 80 %, Chemaf would need to process ore with a cobalt content of 0.51 % to arrive at its production target of 16,000 t/a of cobalt in hydroxide. This contrasts with the average grade of its resources at 0.25 % cobalt. To achieve its production target for cobalt, selective processing of high-grade resources or further expansion of plant throughput may be required. Given Mutoshi's reported total cobalt resources, it is unclear whether this could be maintained over the whole life of mine unless additional resources were discovered.
- Chemaf has not published results from its economic assessments, e.g., operational expenditures, net present value, or detailed CAPEX. This makes an economic evaluation of the project difficult. In general, Chemaf only mentions mineral resources, which are usually reported at lower geological confidence than mineral reserves. In addition, it is not known which formal reporting code (e.g., NI 43-101 or JORC), if any, was used to calculate and present the resources.
- Mutoshi's economic viability is strongly dependent on the cobalt price. Copper and cobalt have traded at highly volatile prices over the past five years. For example, Glencore's Mutanda mine, which has higher ore grades than Mutoshi and is located close by, was put under care and maintenance in 2019 and only re-opened in 2023 due to cobalt price volatility (and other factors).



### 4.20.3 ESG assessment

As internal asset-specific documents such as Chemaf's environmental and social impact assessment for Mutoshi were not available for review, the following statements are based on contextual information or general statements at the company level (assumed to apply to all Chemaf operations), except where noted otherwise. This implies an elevated level of uncertainty for the statements below to apply at the Mutoshi project level, but nonetheless provides a first orientation on its ESG background. Although Mutoshi is planned as an industrial mining operation, international responsible mineral sourcing standards imply addressing the issue of artisanal cobalt (and copper) mining on the concession as well.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                 |
| Environmental management                                           | Chemaf has ISO 14001 certification for its Etoile mine and claims to adhere to IFC performance standards, Equator Principles, and DRC mining code/regulations, all of which include environmental management aspects.                                                                                                                                           |
| Efficient use of energy, renewable energy, GHG emissions reporting | The DRC has one of the world's lowest carbon emission grids due to the high share of hydropower; this may be offset by use of Diesel-fuelled backup generators at mine level during periods of grid instability. Chemaf publicly stated it continuously works on reducing its carbon footprint.                                                                 |
| Water management and consumption                                   | The Kolwezi region is considered a low water stress area, however with medium to high riverine flood risk. No information on water demand and management available.                                                                                                                                                                                             |
| Pollution prevention                                               | Acid mine drainage is a possible risk when (if) handling deeper-seated sulphide ore, but might be somewhat mitigated by the carbonate-bearing wall rock. Kolwezi area shows local surface waters pollution in places.                                                                                                                                           |
| Air quality                                                        | Mine proximity to the city of Kolwezi underlines the importance of air quality monitoring to avoid negative health impact on population.                                                                                                                                                                                                                        |
| Tailings management                                                | No specific information on tailings management available. Chemaf includes re-mining of historical tailings in its mine plan, which might potentially lead to improved tailings storage according to modern standards.                                                                                                                                           |
| Waste management                                                   | Not specifically addressed in company policies. Relevant to consider for a leaching and SX/EW operation (see hazardous materials below).                                                                                                                                                                                                                        |
| Hazardous materials management                                     | Leaching, SX/EW and metal precipitation require processing chemicals such as sulphuric acid, sulphur dioxide, organic extractants, lime and magnesium oxide which have to be disposed of responsibly. In general, Chemaf is familiar with handling such processing chemicals based on its operational experience at Etoile mine and the Usoke plant in the DRC. |
| Noise and vibration                                                | Proximity to the city of Kolwezi underlines importance of monitoring.                                                                                                                                                                                                                                                                                           |
| Protected areas and biodiversity                                   | No corporate policies. The region of Kolwezi is not considered a protected or key biodiversity area. It represents a disturbed environment due to decades of mining operations and their historical legacies.                                                                                                                                                   |
| Mine closure                                                       | No information on mine closure planning and related costs available. Historical mining liabilities on Mutoshi concession call for particular                                                                                                                                                                                                                    |

| ESG category                                                                                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                    | attention on the distribution of management responsibilities for closure and reclamation between Chemaf and Gécamines.                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Social and socio-economic issues</b>                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Community health, safety and security<br>         | Mine located at the outskirts of the provincial capital of Kolwezi with more than 0.5 million inhabitants. On-going mining and mining legacies generally create significant health impacts on residential population, notably due to dust emissions. Past accidents related to sulphuric acid transports of other mines caused community member fatalities. Chemaf states it implements initiatives improving community health. Elevated risk for security incidents and conflict due to on-site activities by artisanal cobalt (-copper) miners. |
| Dialogue and engagement with communities and stakeholders                                                                          | Conflict between former residents and Chemaf due to alleged forced evictions on Mutoshi concession in 2016. Good dialogue with artisanal cobalt miners from 2018-2020, followed by confrontational situation when Chemaf had to terminate an artisanal cobalt sourcing pilot project.                                                                                                                                                                                                                                                             |
| Land acquisition and involuntary resettlement<br> | Amnesty International alleged forced evictions of Mukumbi village residents, situated on Mutoshi concession; the informal village was demolished by the DRC army in 2016. Chemaf denies involvement but agreed to a legal settlement with the community. For other villages on the concession, Chemaf established a protocol to manage resettlement.                                                                                                                                                                                              |
| Occupational health & safety management                                                                                            | Chemaf has a health and safety policy in place for employees and its Etoile mine is ISO 45001 certified. The company supported health and safety of artisanal miners at Mutoshi during a pilot project on cobalt sourcing.                                                                                                                                                                                                                                                                                                                        |
| Workers' rights                                                                                                                    | The DRC scores 64.5/100 in the Labour Rights Index. Chemaf has a detailed employee handbook covering issues like performance-based pay, training and leave. Child labour is prohibited for company employees and for artisanal cobalt miners active on the concession.                                                                                                                                                                                                                                                                            |
| Gender and diversity                                                                                                               | No specific corporate policy. Women are granted maternity leave.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Local value added and community development                                                                                        | Kolwezi hosts several world-class mines; its economy is largely based on mining. Mutoshi would further add to this as a major cobalt and medium-sized copper producer. Mutoshi concession may also host up to several thousand artisanal miners; their future work perspective is unclear.                                                                                                                                                                                                                                                        |
| <b>Governance</b>                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Legal compliance                                                                                                                   | Chemaf has a lease agreement in place with Gécamines, the formal holder of Mutoshi concession.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Management practices                                                                                                               | Chemaf has a short corporate policy on health, safety and environment in place, and a detailed policy on anti-bribery/corruption. Additional policies refer to human rights and mineral supply chain due diligence.                                                                                                                                                                                                                                                                                                                               |
| Transparency and reporting                                                                                                         | The DRC-based company, Chemaf S.A., is a subsidiary of Chemaf Ltd. (and 5% owned by the DRC government), which in turn forms part of the Chemaf Group. Chemaf does not publish comprehensive annual or sustainability reports. Since 2019, it has published annual reports on due diligence activities with an overview on management and policies, details on ore throughput (Etoile mine), health and safety, and due diligence risks.                                                                                                          |

| ESG category    | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Business ethics | The DRC is an EITI member country and a high-risk location in terms of corruption, scoring 20/100 points in the corruption perceptions index (ranked 162 out of 180 countries). Lualaba province is currently listed as a high-risk area by the European Union due to reported human rights violations. Chemaf states it respects the UN Guiding Principles for Business and Human Rights and the OECD due diligence guidance, and has anti-bribery/corruption and human rights policies in place. |

Table 53. ESG features of the Mutoshi project, DR Congo

#### 4.20.4 Further reading

Amnesty International (2023): Powering change or business as usual?

<https://www.amnesty.org/en/documents/AFR62/7009/2023/en/> (accessed: 17.11.2023)

Chemaf Resources Ltd. (2018): Bringing Mutoshi back to life. Development of the Mutoshi cobalt-copper project DRC. [https://www.bgr.bund.de/DERA/DE/Downloads/vortrag-kobalt-nicolle.pdf?\\_\\_blob=publicationFile&v=3](https://www.bgr.bund.de/DERA/DE/Downloads/vortrag-kobalt-nicolle.pdf?__blob=publicationFile&v=3) (accessed: 12.12.2023)

Chemaf Resources Ltd. (2024): Chemaf public documents. <https://chemaf.com/chemaf-public-documents/> (accessed 15.1.2024)

Ilunga P., Samal D., Nicolle M., Lampi M., Valkama K., Edwards J. and Tatalias N. (2018): The Mutoshi Project — Part I: Metallurgical test work, process design, and project delivery. The Journal of the Southern African Institute of Mining and Metallurgy. 118:1171-1178.

Mancini L., Eslava N.A., Traverso M., Mathieux F. (2021): Assessing impacts of responsible sourcing initiatives for cobalt: Insights from a case study. Resources Policy. 71:102015.

Reuters (2020): Trafigura's Congo artisanal cobalt project to end, replaced by industrial mining. <https://www.reuters.com/article/us-congo-mining-idUSKBN28R348/> (accessed: 12.12.2023)

Trafigura Group (2019): The Mutoshi Pilot Project. Local economic impact of a project aimed at formalizing artisanal and small-scale mining. [https://delvedatabase.org/uploads/resources/2019\\_Trafigura\\_the\\_Mutoshi-Pilot\\_Project\\_English.pdf](https://delvedatabase.org/uploads/resources/2019_Trafigura_the_Mutoshi-Pilot_Project_English.pdf) (accessed: 12.12.2023)

## 4.21 Nachu flake graphite project (Tanzania)

Information as of 07/2023

### 4.21.1 General project background

|                                 |                                                                                                                                                                                                                           |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Graphite                                                                                                                                                                                                                  |
| <b>Location</b>                 | Lindi, Tanzania<br>9°54'S 38°52'E, 200-400 m.a.s.l.                                                                                                                                                                       |
| <b>License type</b>             | Special Mining Licence SML No. 550/2015 (29.77 km <sup>2</sup> )<br>Special Export Zone licence (10 years)                                                                                                                |
| <b>License owner / operator</b> | Magnis Energy Technologies Ltd. (public company)                                                                                                                                                                          |
| <b>Contact</b>                  | Aurora Place, Suite 9.03, Level 9, 88 Phillip Street<br>Sydney, New South Wales 2000, Australia<br><a href="http://www.magnis.com.au">www.magnis.com.au</a><br><a href="mailto:info@magnis.com.au">info@magnis.com.au</a> |
| <b>Project status</b>           | Preproduction - construction                                                                                                                                                                                              |
| <b>Production by 2030</b>       | Announced for 2025; a certain delay might be expected, but production by 2030 appears possible                                                                                                                            |



Figure 40. Nachu project location, Tanzania

### 4.21.2 Economic assessment

#### General project background:

The Nachu graphite deposit was discovered in 2013 and is located within the greater Mozambique Metamorphic Belt. The majority of the graphite mineralisation is situated between a depth of 150 and 250 m from surface and hosted within a sequence of graphitic schists as well as minor dolomitic marble and gneisses (both barren). The project is characterised by the expected production of large flake sizes and high purity (>98.5 % total graphitic carbon, TGC) concentrate. Currently, Nachu is the only Tanzanian graphite project with a granted Special Export Zone licence allowing Magnis to produce advanced graphite products as well as downstream products for lithium-ion batteries. Magnis is seeking investment for the construction of the mine and processing plant as well as for on- and off-site infrastructure.

#### Project description:

|                                     |                                                                                                                                                                                                                                                    |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                    | Flake graphite                                                                                                                                                                                                                                     |
| JORC compliant reserves             | 72 Mt @ 5.2 % graphite                                                                                                                                                                                                                             |
| Share of global graphite reserves   | 1.2 % ( <i>USGS estimate global graphite reserves of 320 Mt</i> )                                                                                                                                                                                  |
| JORC compliant resources            | 174 Mt @ 5.4 % graphite                                                                                                                                                                                                                            |
| Share of global graphite resources  | 1.2 % ( <i>USGS estimate global graphite resources of 800 Mt</i> )                                                                                                                                                                                 |
| Waste to ore ratio                  | 1.5 for F Pit (~170 Mt), 1.9 for FS Pit (~22 Mt)                                                                                                                                                                                                   |
| Annual production                   | 5 Mt ore, 236,000 t graphite concentrate (recovery 89.6 %)                                                                                                                                                                                         |
| Share of global graphite production | 23.6 % ( <i>USGS estimate global graphite production of 1 Mt</i> )                                                                                                                                                                                 |
| Life of mine                        | 15.5 years                                                                                                                                                                                                                                         |
| Investment required                 | ~US\$ 363.5m (for construction of mine and processing plant)                                                                                                                                                                                       |
| NPV (post tax)                      | US\$ 1.2bn (assuming US\$ 1,847/t basket graphite concentrate FOB Mtwara and 10 % discount rate)                                                                                                                                                   |
| Value addition potential            | High-purity graphite concentrate (up to 99 %) production within Tanzania. The project requires the construction of 90 km of gas pipeline extensions. Supplying the region with gas also offers opportunities for agriculture and other industries. |

#### Mining and processing:

- The graphite ore will be blasted and hauled from two open pits, namely the F and the FS Pits. Mining considers the extraction of high (>5 % TGC) - and medium-grade (~4.3 % TGC) ore for the first ~12 years (until exhaustion) and the extraction of low-grade (~3.5 % TGC) ore thereafter.
- The ore has an average feed grade of 5.2 % TGC. Graphite flake concentrate yields an average purity of 98.8 % TGC grades, including 98.5 % for >300 µm-sized flakes and 99 % for <300 µm-sized flakes. The ore is crushed in a 3-stage crushing circuit, followed by rod mill grinding and flotation, several stages of regrinding and cleaner flotation dewatering, drying, product handling, and tailings disposal. The final graphite flake (saleable product) is screened into three product size fractions, comprising >500 µm, 500-300 µm and <300 µm and which

contribute to 9 %, 32 and 59 % to the product split distribution. The products are bagged for transportation by truck to a warehouse located at the Mtwara Seaport.

- Magnis assumes operating expenditures (OPEX) of US\$ 639/t basket graphite concentrate during steady state production (year 2 to year 12), including mining, processing, product logistics FOB and general administration. The OPEX excludes sustaining capital and industrial mineral royalties of 3 % as Magnis is exempted from corporate tax and royalties due to their special economic zone licence. Magnis expects a revenue of US\$ 1,847/t basket graphite concentrate FOB Mtwara.

### **BGR assessment and comments:**

- Nachu is a high-tonnage, medium-grade and large flake-size graphite project. The relatively shallow position of the mineralisation should allow for low waste mining (stripping ratio of ~1.5 envisaged). The actual mine plan and reserve estimate does not include TGC grades below 3 %, which yields significant reserve upgrade potential and probable extension of the mine life.
- The project is seeking investment as high as US\$ 363.5m, which reflects the initial CAPEX and includes major infrastructure constructions and upgrades, such as: a natural gas pipeline to the site (~90 km length); a natural gas fired electrical power station and power distribution; a tailings storage facility; bore fields and storm water dams; other relevant infrastructure such as roads, warehouses, camps, facilities etc..
- Magnis is in the process of selecting a location in the USA for their Anode Active Material facility. Magnis has offtake agreements with Traxys (Luxembourg) for 600 kt of graphite concentrate product over a 6-year period (42.4% of annual production) and with Tesla for a minimum of 17.5 kt/a and a maximum of 35 kt/a of Anode Active Material over a 3-year period.
- The Nachu Project is ~20 km from the town of Ruangwa and ~220 km by road from the port of Mtwara. Water is planned to be sourced from groundwater as well as surface water storage (during wet season). Electrical power is planned to be sourced from natural gas mixed with solar and Battery Energy Storage Solutions. Magnis has committed to local communities and the Government of Tanzania to maximize local employment through the employment of skilled people and training of the unskilled.

### **4.21.3 ESG assessment**

The level of publicly available project information is generally adequate. No major ESG issues were identified so far. The company's corporate policies and management systems appear sufficient to prevent conflicts related to the mining operations.



| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                         |
| Environmental management                                           | No reports on incidents found.                                                                                                                                                                                                                                                                                                                          |
| Efficient use of energy, renewable energy, GHG emissions reporting | Change to natural gas instead of heavy fuel oil for onsite power supply and process energy will reduce GHG emission by ~34% (49,943 t CO <sub>2</sub> -eq); solar energy and battery storage planned as part of power supply.                                                                                                                           |
| Water management and consumption                                   | No information on specific water use for operational phase available. Project located in humid area with medium to high water stress. Water supply from combination of ground water and surface water storage; surface water is anticipated to be the main source; processing designed to maximise water recycling. Extremely high riverine flood risk. |
| Pollution prevention                                               | Company reports low amount of sulphides in the ore; AMD potential is seen minimal.                                                                                                                                                                                                                                                                      |
| Air quality                                                        | Smaller villages in the surrounding of the project; possible need for special in care in dust prevention should be examined.                                                                                                                                                                                                                            |
| Tailings management                                                | Tailing storage facility designed in accordance with international standards; consultancies from South Africa and Tanzania are commissioned with design and planning.                                                                                                                                                                                   |
| Waste management                                                   | Conventional approach with mine waste dumps and tailings facility.                                                                                                                                                                                                                                                                                      |
| Hazardous materials management                                     | Flotation technology may imply use of hazardous reagents; Magnis states that no highly hazardous chemicals are involved in processing.                                                                                                                                                                                                                  |
| Noise and vibration                                                | Smaller villages in the surrounding of the project; in case of noise and vibration the distance appears sufficient to be considered as low risk.                                                                                                                                                                                                        |
| Protected areas and biodiversity                                   | The project is not located in or close to a key biodiversity area or other designated protected area.                                                                                                                                                                                                                                                   |
| Mine closure                                                       | Magnis plans conventional remediation for mine pits, waste dumps and tailing facilities; dedicated mine closure plan was not publicly available at this stage.                                                                                                                                                                                          |
| <b>Social and socio-economic issues</b>                            |                                                                                                                                                                                                                                                                                                                                                         |
| Community health, safety and security                              | Project located in the Matambarale ward (~5,000 inhabitants; 2012 census); smaller settlements in the vicinity and scattered settlements in the project area; as resettlement and compensation is already ongoing the potential negative impact on the local population is generally considered a low risk.                                             |
| Dialogue and engagement with communities and stakeholders          | No detailed information on structure of stakeholder engagement available; information on CSR measures etc. indicating functional engagement approach by the company.                                                                                                                                                                                    |
| Land acquisition and involuntary resettlement                      | Resettlement action and compensation plan developed; completion of resettlement village for 59 displaced families in the beginning of 2023.                                                                                                                                                                                                             |
| Occupational health & safety management                            | OHS policy in place. No recordable OHS incident for 2022 companywide.                                                                                                                                                                                                                                                                                   |

| ESG category                                | Assessment                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Workers' rights                             | Tanzania scores 74/100 in the Labour Rights Index. No indication of any deficiencies on the part of Magnis found.                                                                                                                                                                                                                                                                        |
| Gender and diversity                        | Magnis is committed to provide non-discriminated workplaces; diversity policy in place.                                                                                                                                                                                                                                                                                                  |
| Local value added and community development | Magnis is committed to maximise local employment and training. CSR measures comprise building and funding of various schools and clinics in the surrounding villages. Resettlement village designed with sustainable power supply.                                                                                                                                                       |
| <b>Governance</b>                           |                                                                                                                                                                                                                                                                                                                                                                                          |
| Legal compliance                            | ESIA approved by authorities. No indication of any breaches of law found.                                                                                                                                                                                                                                                                                                                |
| Management practices                        | Relevant management policies in place; in compliance with ASX Principles of Good Corporate Governance and Best Practice Recommendations. Comprehensive sustainability framework in development; external consultant employed to review the ESIA and Resettlement Action Plan for deficiencies related to IFC Performance Standards, World Bank Group Guidelines, and ILO Core Standards. |
| Transparency and reporting                  | Listed on the ASX, XFRA, and traded at the OTCQX; information for investors, reports on financial accounts and shareholder structure available.                                                                                                                                                                                                                                          |
| Business ethics                             | Tanzania scores 40/100 in the corruption perception index; Tanzania is an EITI country; Anti-Bribery and Corruption Policy and Whistleblower in place.                                                                                                                                                                                                                                   |

Table 54. ESG features of Nachu project, Tanzania

#### 4.21.4 Further reading

Magnis Energy Technologies (2021): Binding graphite offtake agreement signed with Traxys.

<https://wcsecure.weblink.com.au/pdf/MNS/02468856.pdf> (accessed 21.07.23)

Magnis Energy Technologies (2022): Bankable Feasibility Study Update Confirms Strong Financial and Technical Viability for the Nachu Graphite Project.

<https://wcsecure.weblink.com.au/pdf/MNS/02572799.pdf> (accessed 21.07.23)

Magnis Energy Technologies (2022): Supplementary Information Regarding Nachu BFS Update Released 27.9.2022. <https://wcsecure.weblink.com.au/pdf/MNS/02575700.pdf> (accessed 21.07.23)

Magnis Energy Technologies (2022): Annual Report 2022.

<https://wcsecure.weblink.com.au/clients/magnisenergytech/headline.aspx?headlineid=21406346> (accessed 07.08.23)

Magnis Energy Technologies (2023): Magnis Signs Offtake Agreement for North American Anode Active Material Production. <https://wcsecure.weblink.com.au/pdf/MNS/02633651.pdf> (accessed 21.07.23)

## 4.22 Nkamouna-Mada Ni-Co (-Mn) laterite project (Cameroon)

Information as of 01/2024

### 4.22.1 General project background

|                                 |                                                                                                                                                                                                                                   |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Nickel, cobalt                                                                                                                                                                                                                    |
| <b>Other commodities</b>        | Manganese                                                                                                                                                                                                                         |
| <b>Location</b>                 | Haut-Nyong, East Province, Cameroon<br>3°16' N, 13°51' E, 550 – 750 m.a.s.l.                                                                                                                                                      |
| <b>License type</b>             | Mining license (1,250 km <sup>2</sup> )                                                                                                                                                                                           |
| <b>License owner / operator</b> | GeoCam / Phoenix Mining (60.5 % Geovic Cameroun Plc. (private company), 39.5 % Nat. Invest. Corp. Cameroon (SNI))                                                                                                                 |
| <b>Contact</b>                  | One Marina Park Drive, Suite 1410<br>Boston, MA 02210, United States of America<br><a href="https://cloudbreakholdings.com/support@cloudbreakholdings.com">https://cloudbreakholdings.com/<br/>support@cloudbreakholdings.com</a> |
| <b>Project status</b>           | Feasibility (from 2011)                                                                                                                                                                                                           |
| <b>Production by 2030</b>       | unlikely                                                                                                                                                                                                                          |



Figure 41. Nkamouna-Mada project location, Cameroon

### 4.22.2 Economic assessment

#### General project background:

The Nkamouna-Mada and several other nickel-bearing laterite deposits in southeast Cameroon were first discovered and investigated by the UNDP during 1981-1986. The US company Cloudbreak Holdings through its subsidiary Phoenix Mining acquired the previous operator Geovic Cameroun and its Nkamouna-Mada assets in 2022 and eventually settled its tax debts. Prior to the takeover, the operation had been dormant since 2013 following the publication of a BFS in 2011. The deposits are found in large areas of mineralised laterite, positioned on low-relief plateaus underlain by ultramafic rocks. The laterite weathering profile averages ~20 m thick, while the mineralised laterite forms lenses that are generally more than 10 m thick. The lenses are located parallel to the rolling topography of the plateau and yield high cobalt and manganese contents, subeconomic nickel grades and a nickel to cobalt ratio of less than 3. Mine development has commenced in Q4/2023 and first cobalt and nickel concentrates are expected to be exported in 05/2025.

*Please note that most of the information below is taken from the BFS 2011 and any changes implemented by the new operator have not yet been published.*

#### Project description:

|                                    |                                                                                                                                                               |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Nickel-cobalt-manganese laterite deposit                                                                                                                      |
| NI 43-101 compliant reserves       | 68.1 Mt @ 0.66 % Ni, 0.26 % Co, 1.48 % Mn                                                                                                                     |
| Share of global cobalt reserves    | 2.1 % (USGS estimate global Co reserves of 8.3 Mt)                                                                                                            |
| Share of global manganese reserv.  | 0.1 % (USGS estimate global Mn reserves of 1,700 Mt)                                                                                                          |
| Share of global nickel reserves    | 0.4 % (USGS estimate global Ni reserves of 100 Mt)                                                                                                            |
| NI 43-101 compliant resources      | 323.2 Mt @ 0.61 % Ni, 0.21 % Co, 1.26 % Mn                                                                                                                    |
| Share of global nickel resources   | 0.7 % (USGS estimate global Ni resources of 300 Mt)                                                                                                           |
| Share of global cobalt resources   | 2.7 % (USGS estimate global Co resources of 25 Mt)                                                                                                            |
| Waste to ore ratio (whole orebody) | Expected to be low due to horizontal and near-surface operation                                                                                               |
| Annual production                  | During the first 11 years (BFS 2011) 6,122 t Co contained metal, 62,585 t Mn contained metal, 3,288 t Ni contained metal                                      |
| Life of mine                       | 23 years (BFS 2011)                                                                                                                                           |
| Investment required                | Unknown investment required to complete all the necessary geological, feasibility and environmental studies. Mine construction and development CAPEX unknown. |
| Net present value (NPV)            | Not published                                                                                                                                                 |
| Share of global cobalt production  | 3.2 %, recov. 59 % (USGS estimate global Co prod. of 190 kt)                                                                                                  |
| Share of global manganese prod.    | 0.3 % recov. 53 % (USGS estimate global Mn prod. of 20 Mt)                                                                                                    |
| Share of global nickel production  | 0.1 %, recov. 16 % (USGS estimate global Ni prod. of 3.3 Mt)                                                                                                  |
| Value addition potential           | The second project phase envisages the construction of a refinery at the port of Kribi (Cameroon).                                                            |

**Mining and processing:**

- Conventional open pit methods employing free dig mining of the two ore types, breccia and ferralite, are mined at ~10,000 to 20,000 t/d using excavators and articulated dump trucks. The blended ore will be transported from the pit face to the run-of-mine stockpiles and subsequently to the concentrator (BFS 2011).
- At the concentrator plant, a coarse concentrate (0.9 % cobalt, 0.8 % nickel, 4.8 % manganese) is produced via crushing, screening and milling, and fed to the acid leach and precipitation plant to produce the saleable mixed cobalt-nickel-sulphide product. The residual cobalt and nickel barren solution will be purified and the solution transferred for manganese carbonate precipitation by the addition of soda ash. Metallurgical recoveries are expected to be 59 % cobalt, 53 % manganese and 16 % nickel (BFS 2011).

**BGR assessment and comments:**

- The deposit is a medium-grade, high-tonnage operation with a low waste to ore ratio due to horizontal and near-surface operation. The relatively long life of mine (23 years) can be positive for the development of the region. Due to the presence of several laterite plateaus that have not yet been developed and explored in detail, resource expansions are possible.
- The BFS (2011) demonstrated a positive net present value. Although the data is outdated, cobalt, nickel and manganese prices have increased since then and support the profitability of the project. However, mining and processing costs have also increased. Therefore, it would be important to update this assessment.
- Phoenix Mining is collaborating with four Chinese mining companies and has selected the Chinese construction company Sinohydro for development and construction and Shandong Xinhai Mining Technology to supply the equipment. Phoenix Mining has already approached potential buyers of cobalt and nickel concentrates. Glencore, Trafigura and Traxys have expressed interest. Negotiations are also in progress with Westwin Elements, the first cobalt and nickel refinery project in the United States, in Oklahoma.
- Nkamouna-Mada is located ~400 km east of the capital of Yaounde and ~30 km northeast of Lomié (3,500 inhabitants). The project can be accessed from Yaounde via paved highway to Ayos, an improved gravel road to Abong Mbang and via ~127 km of narrower gravel roads to Lomié and the project site. The closest rail station is located in the town of Belabo (~250 km distance). Suitable shipping and receiving facilities exist at the international seaport of Douala. The second project phase, however, envisages the construction of a refinery at the port of Kribi (~100 km south of Douala) Power supply (16 MW expected demand; BFS 2011) will be provided by diesel generators. Water will be derived from the Edje River and nearby wells.

### 4.22.3 ESG assessment

Due to the early stage of the project information on many ESG aspects and management practices are limited. No sustainability reports or ESG related company information is available on Cloudbreaks or Phoenix Mining website. The assessment is based on the BFS (2011) which was done before the of the project acquisition by Cloudbreak; no information on any change in planning available. To this point no issue could be identified that would preclude a responsible investment.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Environmental management                                           | No information on environmental management available; no reports on any incidents found.                                                                                                                                                                                                                                                                                                                                                                                                  |
| Efficient use of energy, renewable energy, GHG emissions reporting | The BFS (2011) assumed power supply to rely completely on diesel generators, as a grid connection will not be practical. Option to utilise a photovoltaic-battery plant may be assessed in future studies, but has to be weighed against related forest clearing.                                                                                                                                                                                                                         |
| Water management and consumption                                   | Humid equatorial evergreen forest with low water stress; 1,580 mm average precipitation, wet season from September to November, and March to May; medium to high riverine flood risk. Water supply from Edje River; TSF for tailings from concentrator plant is planned in the BFS (2011) to be designed as reservoir for process water by catchment of rainwater during wet season and reclaiming during dry season.                                                                     |
| Pollution prevention                                               | Leaching technology implies the use of hazardous reagents. No information on AMD potential available, however considered low risk from geology.                                                                                                                                                                                                                                                                                                                                           |
| Air quality                                                        | Remote area with high precipitation, no special mitigation measures for dust suppression should be required.                                                                                                                                                                                                                                                                                                                                                                              |
| Tailings management                                                | Different TSFs are planned in the BFS (2011) for the tailings from the concentrator and leaching plant; the TSFs will essentially fill the upper end of the Napene Creek basin to reduce offsite run-on to the facilities thus limiting the need to handle excess waters over the project life. However, it should be assessed if this implies placing tailings in a river/riverine area, which is not considered good international practice in accordance to the most recent standards. |
| Waste management                                                   | No information on waste management available at this project stage.                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Hazardous materials management                                     | Pilot tests for the leaching process including sulfuric acid, pyrite, and sodium sulfate as reagents. As the complete removal of sodium sulfate was assessed as economical not feasible, processing was developed to realise metal recoveries in a sodium sulfate matrix.                                                                                                                                                                                                                 |
| Noise and vibration                                                | Remote area no special noise and vibration mitigation measures should be required.                                                                                                                                                                                                                                                                                                                                                                                                        |
| Protected areas and biodiversity                                   | Area dominated by a series of rolling upland plateaus with equatorial evergreen forest; Project site is not located in or close to any key biodiversity or protected area. However the UNESCO World heritage site                                                                                                                                                                                                                                                                         |



| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | of the Dja wildlife reserve borders the town Lomie (closest town to the mine site). There had been concerns on logging, hunting and of road infrastructure to Lomie impacting the Dja reserve, respective indirect impacts by mining might have to be addressed.                                                                                                                                                  |
| Mine closure                                              | No information on mine closure planning available at this project stage; financial surety will be required for permitting.                                                                                                                                                                                                                                                                                        |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Community health, safety and security                     | Nearest settlement is the village of Kongo around 8 km south from the project site; next major settlement is the town of Lomie (~19,000 inhabitants (2005)) around 25 km southwest from the project site. Distance to settlements appears large enough that negative impact on local population is considered low risk. Main economic activity in the region are logging and minor cocoa and palm oil production. |
| Dialogue and engagement with communities and stakeholders | No information available at this project stage.                                                                                                                                                                                                                                                                                                                                                                   |
| Land acquisition and involuntary resettlement             | No indication of significant settlement in the area. A Land Lease configuration was approved by the Cameroon Prime Minister on August 21, 2008; no information on current status available.                                                                                                                                                                                                                       |
| Occupational health & safety management                   | No specific information on OHS management at this project stage; remoteness of area will require provision of emergency services on site.                                                                                                                                                                                                                                                                         |
| Workers' rights                                           | Cameroon scores 59/100 in the Labour Rights Index.                                                                                                                                                                                                                                                                                                                                                                |
| Gender and diversity                                      | No information on gender and diversity policies available.                                                                                                                                                                                                                                                                                                                                                        |
| Local value added and community development               | Majority of workers to be recruited regionally (600 workers planned for construction phase; technical and scientific staff to be recruited national.                                                                                                                                                                                                                                                              |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Legal compliance                                          | ESIA received Certificate of Conformity on 29 May 2007; consolidation of ESIA, ESIA update, and BFS (2011) was required by legal authority, no information of actual status.                                                                                                                                                                                                                                      |
| Management practices                                      | No specific information on management practice available on company website.                                                                                                                                                                                                                                                                                                                                      |
| Transparency and reporting                                | Private company. No financial or investors reports available on website.                                                                                                                                                                                                                                                                                                                                          |
| Business ethics                                           | Cameroon scores 27/100 in the Corruption Perception Index. Cameroon is suspended by EITI. No ESG policies, code of conduct etc. on company website. No indication of any unethical practices on the side of Cloudbreak or Phoenix Mining found.                                                                                                                                                                   |

Table 55. ESG features of Nkamouna-Mada project, Cameroon

#### 4.22.4 Further reading

Africa Intelligence (2022a): Phoenix Mining manoeuvres in Yaoundé to relaunch Nkamouna cobalt project. <https://www.africaintelligence.com/central-africa/2022/10/06/phoenix-mining-manoevres-in-yaounde-to-relaunch-nkamouna-cobalt-project,109831933-art> (accessed: 09.01.2024)

Africa Intelligence (2022b): Battle over Nkamouna-Mada cobalt. <https://www.africaintelligence.com/central-africa/2022/06/20/battle-over-nkamouna-mada-cobalt,109793182-art> (accessed: 09.01.2024)

Africa Intelligence (2023a): Phoenix Mining settles differences with Yaoundé so as to resume cobalt project. <https://www.africaintelligence.com/central-africa/2023/04/12/phoenix-mining-settles-differences-with-yaounde-so-as-to-resume-cobalt-project,109934295-art> (accessed: 09.01.2024)

Africa Intelligence (2023b): Phoenix Mining poised to start mining in November with Yaounde's backing. <https://www.africaintelligence.com/central-africa/2023/06/27/phoenix-mining-poised-to-start-mining-in-november-with-yaounde-s-backing,109997905-art> (accessed: 09.01.2024)

SRK Consulting (2011): NI 43-101 Technical Report - Geovic Mining Corp. - Nkamouna and Mada Deposits - East Province of Cameroon, Africa. (accessed: 09.01.2024)

## 4.23 Nyakabingo quartz vein-hosted W project (Rwanda)

Information as of 11/2023

### 4.23.1 General project background

|                                 |                                                                                                                                                                                                                                   |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Tungsten                                                                                                                                                                                                                          |
| <b>Location</b>                 | Shyorongi Sector, Northern Province, Rwanda<br>1° 52' S , 29° 59' E, 1,840 m.a.s.l.                                                                                                                                               |
| <b>License type</b>             | 002/MINIRENA/2015 (valid until 28-01-2040)                                                                                                                                                                                        |
| <b>License owner / operator</b> | Eurotrade International Ltd.<br>(owned by Trinity Metals Group)                                                                                                                                                                   |
| <b>Contact</b>                  | Trinity Metals Group                                                                                                                                                                                                              |
| Direct contact established: Yes | Masoro, Rulindo<br>P.O Box: 6132 Kigali-Rwanda<br>+250 791 959 034<br><a href="https://trinity-metals.com">https://trinity-metals.com</a><br><a href="mailto:peter.geleta@trinity-metals.com">peter.geleta@trinity-metals.com</a> |
| <b>Project status</b>           | Mining                                                                                                                                                                                                                            |
| <b>Production by 2030</b>       | Already in production (small scale); expansion possible by 2030                                                                                                                                                                   |

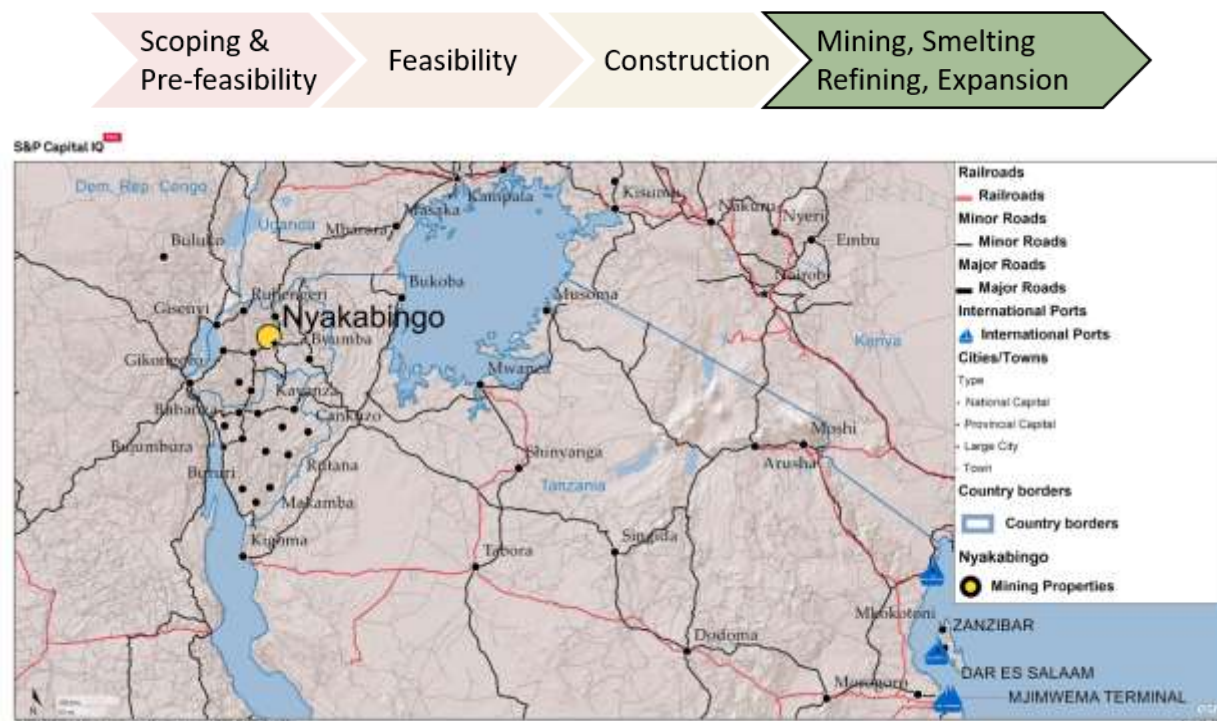


Figure 42. Nyakabingo project location, Rwanda

### 4.23.2 Economic assessment

#### General project background:

The Nyakabingo small-scale mine is located about 19 km (by road) north-west of Kigali in the Northern Province of Rwanda. The owner of Nyakabingo mine, Trinity Metals Limited, owns a 25-year mining license starting from 2015. The operation currently produces 50 tonnes of tungsten concentrate containing 65-70%  $\text{WO}_3$  per month. The resources at Nyakabingo contain about 7,000 t  $\text{WO}_3$  (defined in 2013 by an independent report) with a grade of 3-6 kg  $\text{WO}_3/\text{m}^3$ , corresponding to 0.11-0.23%  $\text{WO}_3$ , assuming a rock density of the veins of 2.65 t/ $\text{m}^3$ . The grade is typical for medium- and small-scale mining activities.

Exploration of alluvial deposits in the area began in the late 1930s, but it was only after WWII that systematic open cast mining began. Underground mining started in the late 1960s with adits, followed by cross-cuts along quartz veins situated in bedding planes (known as concordant parallel veins). These deposits are mined by dip raises and stoped by room and pillar mining, whilst the steeper dipping, discordant veins (known as cross veins) are mined by open stoping.

Trinity Metals intends to invest over US\$ 60m in its existing projects at Nyakabingo, Rutongo (tin) and Musha (tin, tantalum and lithium) over the next three to five years, with a focus on efficiency and modernising of operations. Currently, the company has been using small plant units to upgrade the mined ore. In the future, they plan to construct larger processing plants to produce marketable concentrates at the mine sites, when the mining operations are extended.

#### Project description:

|                                     |                                                                                                                                                                                            |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                    | Wolframite-bearing quartz veins                                                                                                                                                            |
| Non code compliant resources        | Nyakabingo: 4 Mt @ 0.17 % $\text{WO}_3$ (2013)                                                                                                                                             |
| Share of global tungsten resources  | 0.15 % ( <i>USGS estimate global W reserves of 3.8 Mt</i> )                                                                                                                                |
| Waste to ore ratio (whole orebody)  | Unknown at Nyakabingo, probably low because of the underground selective mining method                                                                                                     |
| Annual production                   | Current output about 400 t of $\text{WO}_3$ (320 t tungsten content)                                                                                                                       |
| Life of mine                        | Static lifetime of Nyakabingo 17.5 years (starting from 2013; however actual remaining reserves unknown)                                                                                   |
| Investment required                 | Unspecified investment for modernising and potentially expanding the small-scale mine                                                                                                      |
| Net present value (NPV)             | Unknown (value of annual production in 2022 about US\$ 8.75m)                                                                                                                              |
| Share of global tungsten production | 0.38 % ( <i>USGS estimates global W production of 0.084 Mt in 2022</i> )                                                                                                                   |
| Value addition potential            | Refining of tungsten concentrates could take place in Rwanda if a tungsten refinery for the entire national tungsten production would be built. However, no concrete plans exist for that. |

**Mining and processing:**

- The only commodity at the Nyakabingo concession is tungsten (wolframite is the main tungsten-bearing mineral). Historical mining resulted in the creation of open pit mines on the flank of the pre-existing valley and underground workings. Historical production from colonial era operations and artisanal miners between 1952 and 1985 is estimated at >2,700 t WO<sub>3</sub>. The underground mining at Nyakabingo is based on vein-type deposits hosting coarse-grained wolframite grains. The thickness of the mineralised veins is variable and can range between a few decimetres up to 2 m.
- Mine access is provided through about a dozen horizontal adits placed at different levels of hill slopes. Inside the mine, adits connect to cross-cuts and internal shafts that provide access to the various stopes. Ore is extracted manually using jackhammers. Transport inside the tunnels is done by wheelbarrows and track bound dump cars to the surface, while transport of ore from the adit mouth to the upgrading stations is done by trucks. For hoisting between the levels, small electric winches are installed. As a supplement for the natural ventilation of the mine, small electric blower fans are installed in the galleries near the stopes.
- The run of mine ore is upgraded by handpicking and then crushed. The size-reduced ore is washed and then sorted by gravitation in sluices and shaking tables to obtain saleable tungsten concentrates after drying in a processing plant as final product.

**BGR assessment and comments:**

- The remaining Nyakabingo deposit would be the base for a medium-grade, medium-tonnage (run of mine 150 – 190 kt ore/a) underground operation although, according to the current official mining license classification in Rwanda, this production is considered as “large-scale mining” operation at a national scale. Resource expansions are possible due to the potential vertical extension of the deposit.
- The mining methods in use, i.e. room and pillar for (sub)horizontal veins and open stoping for steep dipping veins, are safe when well managed.
- Gravity sorting of Nyakabingo wolframite ore is well-known and poses no technical risk.

### 4.23.3 ESG assessment

The level of publicly available project information is limited. However, Nyakabingo is a brownfield project with a production history dating back to the 1930s. Therefore, the mining impacts are well known and can be extrapolated to the new project planning phase. Negative impacts could be expected by blasting effects on the surface and subsidence at the surface since several buildings of the Shyorongi village are located relatively close to the underground excavation zones. According to Trinity Metals, the company complies with guidelines and standards from leading local and international bodies. They have adopted the Certified Trading Chain (CTC) standard and various policies and standards to ensure ethical business conduct and responsible practices pertaining to human rights, labour rights and the environment as well as responsible supply chains (OECD). High local content related to employees and local procurement.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                 |
| Environmental Management                                           | Company policies includes commitment to establish and implement an environmental management system addressing risks and impacts to the environment as well as environmental reporting and target setting.                                                                       |
| Efficient use of energy, renewable energy, GHG emissions reporting | There are plans to reduce and offset carbon emissions and utilise eco-conscious mining methods and technology. Trinity Metals has planted more than 657,000 trees across its three mine sites. According to IRENA, Rwanda's electricity mix has around 50 % renewables (2022).  |
| Water management and consumption                                   | Over 90 % of the water used is recycled and no process water is discharged. Water from the tailings storage facility is managed in a closed-circuit operation. The overall annual water stress at the mining sites is considered as low; riverine flood risk as extremely high. |
| Pollution prevention                                               | Trinity Metals intends to prevent pollution and avoid or minimise waste generation by actively promoting reuse, recycling, and resource efficiency.                                                                                                                             |
| Air quality                                                        | Scarcely populated area, and OHS management in the mine and at the processing site is in place, considered low risk.                                                                                                                                                            |
| Tailings management                                                | The current production rate of about 15,000 t ore/month requires a medium-sized TSF. The mine tailings are chemically inert; therefore, no lining of the TSF is required.                                                                                                       |
| Waste management                                                   | Unknown. Low at Nyakabingo, due to underground mining and hand stowing of waste for roof support.                                                                                                                                                                               |
| Hazardous materials management                                     | No hazardous materials are used in mineral beneficiation and in consequence the risk is considered low.                                                                                                                                                                         |
| Noise and vibration                                                | OHS management is in place at Nyakabingo. Mine is located in a scarcely populated area, therefore the impact risk is generally considered low, though more significant for the local village close by.                                                                          |
| Protected areas and biodiversity                                   | Project not located in or near a protected area; however, Nyakabingo is located at a tributary to the Nyabarongo River that is a key biodiversity area. The Nyabarongo River carries a high sediment freight caused by erosion. Expected biodiversity impacts are low.          |



| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mine closure                                              | Trinity Metals is maintaining and updating a plan for the eventual closure of mining operations, including management of social and environmental impacts, estimates of closure costs, and financial provisions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Community, health, safety, and security                   | Trinity Metals claims that it has developed a social risk management framework to capture all social risks and opportunities, which is periodically updated. It identifies all hazards, and assesses the associated risks while taking appropriate actions to manage these risks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Dialogue and engagement with communities and stakeholders | Trinity Metals policy requires engaging regularly with all relevant stakeholders, including host communities and local government institutions, through appropriate channels. Trinity Metals invests in community-based mining cooperatives in coordination with the Rwanda Mines, Petroleum and Gas Board (RMB). Trinity Metals claims to provide community-based miners with the training, tools, and infrastructure required to operate safely and legally. There is no information available related to a structured dialogue with communities.                                                                                                                                                                                                                                                                                                          |
| Land acquisition and involuntary resettlement             | Trinity Metals's social performance policy claims to avoid physical and economic displacement of host communities and, where unavoidable, follows a proper consultation process with affected communities; they claim to follow legal provisions for expropriation and fair and timely compensation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Occupational health & safety management                   | According to its OHS policy, Trinity Metals and its affiliated companies are committed to identifying all hazards and assessing the associated risks while taking appropriate action to manage these risks. They are committed to investigate and act on all health and safety incidents, to awareness and engaging all employees and stakeholders in a health and safety management system, and to ensure continuous improvement in managing health and safety performance by setting clear objectives and measurable targets. An OHS policy is in place. The underground mining activities require safety measures that are appropriated to small-scale mining issues.                                                                                                                                                                                     |
| Workers' rights                                           | Trinity Metals is not certified by ISO norms or abiding by ILO conventions but is following several guidelines to secure safety and health, fair remuneration (including stakeholders), continuous training for their employees, and reviews business practices of their business partners. Trinity Metals tries to prevent, mitigate, and, where appropriate, remedy any human rights impact that they may have caused or contributed to and take appropriate action where they identify violations of this policy by employees or business partners, including termination of employment or contract and referral to the relevant authorities and publicly communicate their human rights management approach and performance in their annual reporting. The 2022 labour right score of Rwanda is 63.5 generally indicating limited access to decent work. |
| Gender and diversity                                      | According to its human rights policy, the company intends to foster an environment that promotes diversity and inclusion.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| ESG category                                | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Local value added and community development | According to the social performance policy of Trinity Metals, they want to create benefits for host communities by prioritising local content support in the form of employment, procurement, and investing in social development projects. The total workforce for all three mines of Trinity Metals in Rwanda is about 4800. The company claims that more than 99% of employees are local workforce and 70 % of the materials used in the operation are procured locally.                                                                                                                                                                                                                                                                                                                                     |
| <b>Governance</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Legal compliance                            | No indication of any violation of the law found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Management practices                        | Trinity Metals has adopted relevant policies related to ESG requirements in its code of conduct; policies and standards are laid out for: anti bribery and corruption, OHS, social performance, whistleblowing, human rights and environment. Information on related certifications not available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Transparency and reporting                  | The Company claims that it abides by the principles set out in the 2016 OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from conflict-affected and high-risk areas. The company is inspected by the Rwanda Mines Petroleum and Gas board (RMB) according to the Regional Certification Mechanism (RCM) standard, however no information available on independently conducted third-party audits.                                                                                                                                                                                                                                                                                                                                                                                          |
| Business ethics                             | The company has a Code of Conduct that sets out the required principles and standards with which the board, management, and employees of the Company must comply when conducting company business and dealing with each other, the shareholders, stakeholders, and the broader community. No policy related to supply chain due diligence published (as per OECD requirement); the company claims to have certification of minerals as “conflict-free” as well as full traceability. There are anti-corruption and bribery as well as whistle-blowing policies. Rwanda is not part of the CAHRAs list but may be considered a red-flag location due to mineral smuggling risks. Rwanda ranks 49/180 in the Corruption Perception Index (ranking 3 <sup>rd</sup> best in Africa). Rwanda is not an EITI country. |

Table 56. ESG features of Nyakabingo project, Rwanda

#### 4.23.4 Infrastructure assessment

##### Potential Investment Needs:

- **Railway Enhancements:** A need to extend the rail line from Kigali city to a mine location less than 20 km away.
- **Renewable energy ventures:** Investment opportunity to link the project with region’s abundant hydro potential.

- **Water Supply:** Investment opportunity to finalize the three water dams for mine wastewater collection, treatment, and recycling.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | Nyakabingo is a tungsten ore mine owned by Trinity Metals and sits 19 km (by road) to the northwest of Kigali in the Northern Province of Rwanda, near the village of Shyorongi. The mine produces more than 50 tonnes per month under a 25-year license that began in 2015.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Transport                 | The Rwanda road network has improved through rehabilitation and upgrading during the past years. The total road network covers 7,500 km of paved roads and 11,346 km unpaved roads, making a total of 18,846 km. The paved National Road 2 (NR2, Kigali-Ruhengeri Rd) passes through Nyakabingo mine site, which will be used as a transport route to the NR4 via the NR1 through Kigali, which subsequently leads to neighbouring Tanzania. Rwanda's capital, Kigali, is merely 19 km by car from the project site.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Airport                   | The country's main gateway is the Kigali International Airport, serving the domestic and several international destinations. The airport is home to the country's national carrier RwandAir, as well as hosting different international airlines serving multiple destinations. The Rwandan government has invested in the construction of the New Bugesera International Airport (NBIA), where works have been underway since 2017. Located some 40 km south of Kigali along the NR5, the airport aims to complement Kigali International Airport. The new airport will provide both extra capacity for passenger transport and cargo freight. Total construction is expected to be complete by 2024 and will include a 4.2 km runway, cargo terminal, and passenger terminal with capacity for 4.5 million passengers per year. Both airports are readily accessible to the mine and may be used for cargo exports.                                                                                                                                                                                                                  |
| Rail access               | Rwanda currently has no railway network. Development of two major regional lines to link the country to the major seaports of Mombasa and Dar es Salaam have been underway. Development of the Dar es Salaam – Isaka - Kigali railway project, which will connect Kigali (Rwanda) from Isaka to the Tanzanian port of Dar es Salaam, is still seeking financing. The segment from Dar es Salaam to Isaka (1,223 km) is currently being upgraded. This segment, however, requires a further US\$ 1.8bn in funding for the completion of Lots 3 and 4. Construction of the remaining 400 km segment between Isaka and Kigali is estimated to cost US\$ 2.5bn The Mombasa – Nairobi – Kampala - South Sudan - Kigali standard gauge railway forms part of the Northern Corridor Integration Project, an East African Community regional effort to develop a railway system network that will link the four partner states to stimulate trade and reduce the costs of business. Once completed, both railways will serve the project via Kigali, whilst furthermore linking the land-locked nation to two significant international ports. |
| Port                      | The ports of Dar es Salaam in Tanzania and Mombasa in Kenya are the two most accessible seaports to transport raw materials for exports to international markets. Access to the ports is currently only possible by means of road or a combination of road and rail transport. The port of Dar es Salaam is one of East Africa's leading freight gateways; a growing entry and exit of goods for local market and to many landlocked countries across East and Central Africa. The port is Tanzania's principal port with a rated capacity of 14.1 million t dry cargo and 6.0 million t bulk liquid cargo. The port has a total quay length of about 2,600 m with eleven deep-water berths. Dar es Salaam port                                                                                                                                                                                                                                                                                                                                                                                                                        |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | <p>handles about 95 % of the Tanzania international trade. The Tanzanian Ports Authority recently signed a 30-year concession agreement with Dubai's logistics multinational DP World to upgrade the Port of Dar es Salaam. This includes an initial investment of US\$ 250m during the first phase, and an overall projection of US\$ 1bn. This will go towards "cutting-edge technologies and advanced equipment", to boost the port's annual cargo handling capacity from its current 750,000 TEU. Initially, the investment will focus on improving cargo-clearing systems and eliminating delays, but potential future investments include temperature-controlled storage to enhance Tanzania's agricultural sector, as well as improved connections to hinterland rail freight links. Mombasa is located on the east coast of Africa approximately midway between the South African port of Durban and major ports in the Red Sea and the Middle East. It is Kenya's and indeed East Africa's biggest and busiest seaport. The port is the main gateway to East and Central Africa serving a vast hinterland of more than 120 million people in Kenya, Uganda, Rwanda, Burundi, Eastern DRC, South Sudan, Ethiopia, Somalia, and Northern Tanzania. The Port of Mombasa has a length of 13 km, a width of 300 m, and a maximum depth of 15 m. The inner harbour has a tidal range of 3.5 m. To find a sustainable solution to market barriers, Rwanda has established an East Africa inland port through its partnership with Dubai Port. Rwanda's Inland port named Kigali Logistics Platform offers warehousing services, transportation services, cold storage, and container storage services. It is expected to help Rwanda save up to US\$ 50m from reduction of logistics cost. To support trade and ease transportation of imported cargoes, the Kenya Ports Authority and Tanzania Ports Authority opened a liaison office in Kigali in July 2013. The office allows importers to track their cargo from Kigali and pay port dues directly at Kigali.</p> |
| Energy       | <p>Information about energy usage and power infrastructure on-site is not available. Power infrastructure, however, is available along the NR2 highway, where power is presumably sourced from. Currently, the total installed capacity to generate electricity in Rwanda is 332.6 MW from different power plants. By generation technology mix, 51 % is from thermal sources, followed by hydro sources with 43.9 %, and solar sources with 4.2 %. Ongoing projects include the Rusumo Falls, Rusizi III, and Nyabarongo II hydropower plants, in an effort to add more capacity on the existing national grid. Implementation and integration of renewable energy sources need to be assessed case-by-case.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| GHG emission | <p>Trinity Metals is rated green in all three of its operations, however, no information is available regarding their carbon emission reduction strategy. To curb CO<sub>2</sub> emissions, however, investments should be directed towards supporting the expansion of the renewable energy sector, especially with regards to the region's abundant hydro potential.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Water        | <p>According to Trinity Nyakabingo Mine's annual due diligence report in 2022, Nyakabingo started a project involving the construction of three water dams for mine wastewater collection, treatment, and recycling, to avoid the water flowing from the mine to the community farms and the pollution of natural waterways. Literature about water sources for the three Trinity mines is not available online.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

Table 57. Infrastructure assessment of Nyakabingo project, Rwanda

#### 4.23.5 Further reading

Trinity Metals' internet home page contains the policies, standards, and code of conduct of the company. <https://trinity-metals.com/home/sustainability/> (accessed 16.10.23)



## 4.24 Sangarédi bauxite (Al) project (Guinea)

Information as of 01/2024

### 4.24.1 General project background

|                                 |                                                                                                                                                                                                 |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Bauxite                                                                                                                                                                                         |
| <b>Location</b>                 | Boké Prefecture, Boké Region, Guinea:<br>11°5' N, 13°46' W (WGS 84), 139 m.a.s.l.                                                                                                               |
| <b>License type</b>             | The mining right covering 690 km <sup>2</sup> at Sangarédi/Boké will expire in 2038 if not extended.                                                                                            |
| <b>License owner / operator</b> | Compagnie des Bauxites de Guinée (CBG)<br>(owned by Halco Mining Inc. (51 %) and the Guinea gov. (49 %)). Halco is a consortium of Rio Tinto (45 %), Alcoa (45 %) and Dadco Investments (10 %). |
| <b>Contact</b>                  | Direction Générale Sise à Kamsar – B.P: 100<br>Conakry: 9eme Etage, Immeuble Zein – B.P: 523<br><a href="mailto:info@cbg-guinee.com">info@cbg-guinee.com</a>                                    |
| <b>Project status</b>           | Mining                                                                                                                                                                                          |
| <b>Production by 2030</b>       | Already producing mine; expansion possible by 2030                                                                                                                                              |

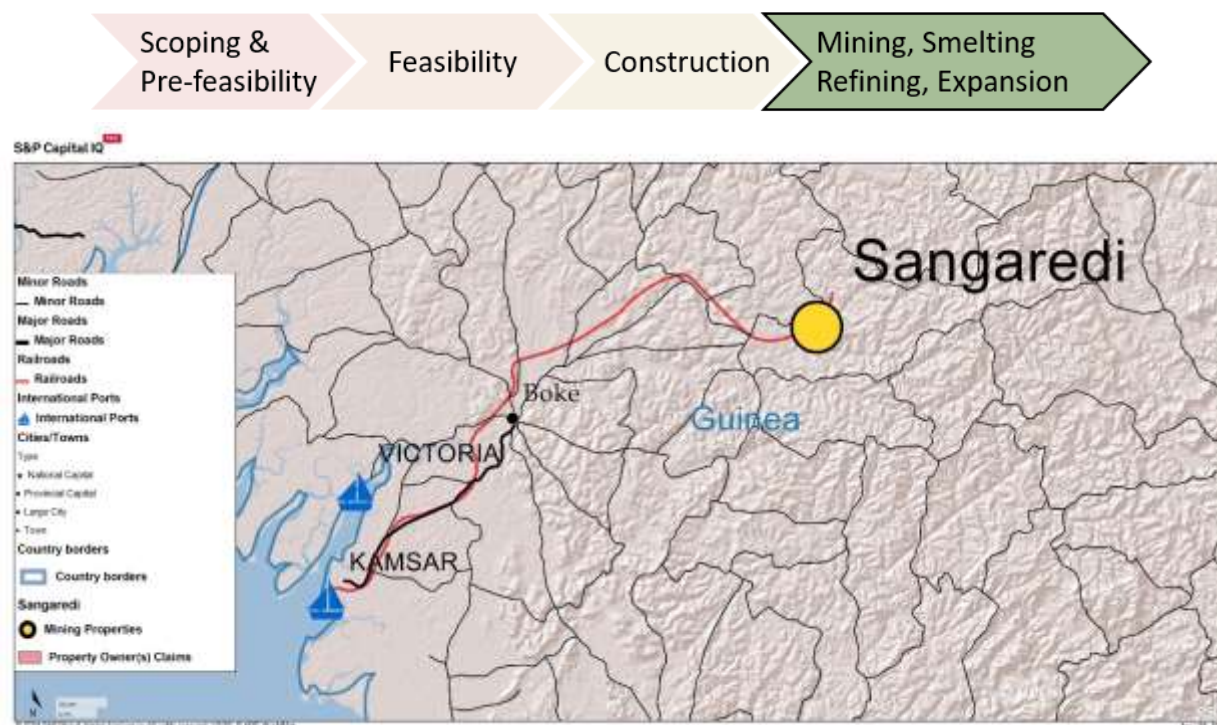


Figure 43. Sangarédi mine site, Guinea



### 4.24.2 Economic assessment

#### General project background:

The Sangarédi Mine is one of the largest bauxite mines in the world. The ore is considered as high quality ore due to its high alumina content and low silica content. The presented project entails the expansion of Compagnie des Bauxites de Guinée's ("CBG" or the "Company") Sangarédi bauxite mine, processing plant and associated infrastructure, located in northwest Guinea, at a cost of US\$ 752m. The proposed expansion will increase production capacity from 13.5 Mt/a to 18.5 Mt/a by 2024. Additional expansion programs for ramping up to 28.5 Mt/a are under discussion. This would require the increase of the production capacity of the mine and an enhancement of the surrounding infrastructure such as the railway, processing plant, port, power plants and housing estates.

#### Project description:

|                                    |                                                                                                                                                        |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Laterite (bauxite)                                                                                                                                     |
| None code compliant reserves       | 603 Mt @ 46.9 % $\text{Al}_2\text{O}_3$                                                                                                                |
| None code compliant resources      | 11,038 Mt @ 46.5 % $\text{Al}_2\text{O}_3$                                                                                                             |
| Share of global bauxite reserves   | 1.95 % ( <i>USGS estimate global bauxite reserves of 31 Bt</i> )                                                                                       |
| Share of global bauxite resources  | 15 – 20 % ( <i>USGS estimate global bauxite resources of 55 - 75 Bt</i> )                                                                              |
| Waste to ore ratio (whole orebody) | Unknown, but supposed to be low due to near surface mining                                                                                             |
| Annual production                  | Current output about 17.2 Mt of bauxite ore                                                                                                            |
| Life of mine                       | Static lifetime >30 years                                                                                                                              |
| Investment required                | US\$ 752m for current mine expansion to 18.5 Mt throughput                                                                                             |
| Net present value (NPV)            | Unknown                                                                                                                                                |
| Share of global bauxite production | 4.5 % ( <i>USGS estimates global bauxite production 380 Mt in 2022</i> )                                                                               |
| Value addition potential           | Alumina production could take place in Guinea; there are additional projects in the region that would support the construction of an alumina refinery. |

#### Mining and processing:

- The Sangarédi site is an open-pit mine including the following operations: stripping, drilling, blasting, loading and hauling. The blasted bauxite is loaded into 77-100 t trucks and transported to the homogenisation stockpiles at N'Dangara. Afterwards it is loaded by wheel loaders into railway cars that are put together into trains (120 cars of 82 tonnes each) which transport the bauxite ~135 km from Sangarédi to the city of Kamsar, close to the port.
- At Kamsar the raw material is unloaded and crushed in a plant to reduce oversize material. After crushing, the ore is transferred to the production control stocks. Four drying kilns are reducing the moisture content to about 7 %. The dried bauxite is then conveyed to a jetty for loading onto ships with capacities ranging from 50 to 70 kt on average.

- In Kamsar, the installations include the following assets: locomotive repair shop, railway cars unloader, primary crusher, secondary crusher, scrubbers, conveyors, stacker, reclaimer, bauxite dryers, dry bauxite storage, bauxite sampling tower, power house, jetty and ship loader. All installations would have to be upgraded and/or enlarged for the planned additional capacity.

### **BGR assessment and comments:**

- The bauxite deposits at Sangarédi facilitate a long life bauxite mine. The relatively long remaining life of the mine (>30 years) is considered potentially positive for the development of the region. Simple mining and processing technologies are utilized that can ensure a high production rate.
- Because of the planar extension of the deposit a rapid extension of the production rate is easily possible. However, the increase of transport capacities (railway and port facilities) will require considerable financial resources and time.
- The construction of an alumina plant at Kamsar could be an option to increase value addition of bauxite mining in Guinea. In this case the safe deposition of the residues (red mud) has to be assured. The sources for energy supply are not yet defined.

### **4.24.3 ESG assessment**

Detailed yearly independent audit reports starting in 2019, latest report 2022 available. (on behalf of lender organisations (IFC; US IDF, BNP Paribas; ING Bank, Natixis and BICIGUI SA)). Also provisional certification against the Performance Standard V2 of the Aluminium Stewardship Initiative (ASI) (08/2023) that addresses all relevant ESG issues.

Sangarédi is a brownfield project with a production history dating back to the 1960s. Therefore, the general mining impacts are well known. Major issues reported in the actual audit report relate among others to the elevated oil concentration in the water treatment plant in Kamsar, the uncompleted stack emission testing and the deficient livelihood restoration activities in resettlement areas. The most important ESG issues of Sangarédi seems the resettlement of villages and the water supply of communities affected by mining activities.

| ESG category                                                                                             | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Environmental Management                                                                                 | CBG is certified to ISO 14001 : 2015 and has adopted all IFC Performance Standards including in particular the environmental and social performance standards of the IFC including on environmental management. The general policy and the management systems were assessed against the ASI Standard Version 2 in 2023 and were rated as fully compliant.                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Efficient use of energy, renewable energy, GHG emissions reporting                                       | GHG emissions were calculated according to the GHG Protocol by an external expert between 2018 and 2022. Scope 1 and Scope 2 emission types were calculated to about 340,000 t CO <sub>2</sub> -ep using IPCC emission factors, this results in approximately 25kg CO <sub>2</sub> -ep per tonne of Bauxite mined. Annual emissions are published in the Entity's Sustainability Report. In 2020, 61 % of installed electricity generation was from renewables (hydropower; IRENA 2022)                                                                                                                                                                                                                                                                                         |
| Water management and consumption                                                                         | CBG is providing water for both the plant in Kamsar and the community (both surface and ground water) which is considered as currently appropriate to local demand (ASI 2023). The annual consumption and wastewater data are available in the Sustainability Report: 0.95 Mm <sup>3</sup> for industrial and 6 Mm <sup>3</sup> for residential use at CBG. Sediment load to the river and finally the ocean is a problem. Water discharged to the river is monitored by the Entity. Retention basins are in use for the collection of surface wastewater during the wet season. There are complaints of communities with regard to water supply. Poor performance of waste water treatment plant documented in 2022. Water stress is considered low; riverine flood risk high. |
| Pollution prevention  | CBG has established a relevant objective for the prevention and reduction of spills and leakages to the environment (ASI 2023). Risk assessments are undertaken and an overview of potential risks (including for rail and road) is also documented. Relevant management plans have been developed, and a separate plan has been developed for contractor organisations. Potentially affected Stakeholders that could be impacted by spills or leakage have been identified and mapped.                                                                                                                                                                                                                                                                                         |
| Air quality                                                                                              | Air emissions monitoring at both the port and mine, as well as along on the transportation routes. The results are checked by the government. According to the ASI report CBG is not in full conformance as the mobile measurement equipment is not calibrated.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Tailings management                                                                                      | There are no processing tailings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Waste management                                                                                         | Waste management plan is available, primary operational waste management facilities located in Sangarédi and Kamsar; CBG intends to develop a longer-term waste management strategy (2022).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Hazardous materials management                                                                           | CBG is committed to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. All major chemical storage facilities and infrastructure have been mapped, and CBG maintains a registry for all hazardous materials.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Noise and vibration                                       | Noise impacts adjacent to railway had been reported, mitigation measures had been recommended by auditor to avoid resettlement (Ramboll 2022), no recent information.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Protected areas and biodiversity                          | Project not located in or close to a key biodiversity land area. However the Kamsar Plant is located in a distance of 20 km north of the Marine Protected Area Rio Kapatchez. Expected biodiversity impacts are low.                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Mine closure                                              | A Mine Rehabilitation and Conceptual Closure Plan is available with action to begin 2028 (Ramboll 2022), it also states CBG has no formal procedure for managing mined land rehabilitation with respect to community involvement and relinquishment.                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Community, health, safety, and security                   | According to the Global Human Settlement classification, Sangarédi can be categorized as urban center. The closest distance between the mining installations and the houses at Sangarédi is about 400 m. However, the distance to the railway tracks is less than 10 m, rail-related noise and safety issues are very relevant. Rail-related risks are being addressed by fencing and footbridges.                                                                                                                                                                                                                                                             |
| Dialogue and engagement with communities and stakeholders | CBG has developed a draft community engagement plan for 2022-2025 which was under review by relevant parties, but no information on finalization available. Recruitment of a Community Engagement Coordinator at Sangarédi was recommended (2022). No information available on a structured dialogue with communities. CBG claims that it has invested over US\$ 60m in the development of infrastructure and basic social services for local communities and since 2017, up to US\$ 2.5m in the socio-economic development of communities.                                                                                                                    |
| Land acquisition and involuntary resettlement             | CBG states that it's resettlement policy is aligned with IFC standards. CBG has developed an Action, Resettlement and Compensation Plan (PARC) in consultation with the village residents. In 2020 CBG completed the relocation of the inhabitants of Hamdallaye village (more than 600 people). As part of the PARC, CBG states it has built 173 houses, a health clinic, a school, a mosque, a market and a multi-purpose community centre. Six boreholes for drinking water were also built. However, there have been complaints from resettled persons of the village that claim that CBG was failing to meet the correspondent IFC Performance Standards. |
| Occupational health & safety management                   | CBG is certified to ISO 45001:2018 (as well as OHSAS 18001) and has the vision to achieve Zero Lost Time Injury. CBG has implemented the Incident Cause Analysis Method (ICAM) System for the investigation of work-related incidents. However, 3 workers fatalities and 8 non-fatal incidents in 2021 were reported as well as deficiencies in corrective action and mitigation of OHS risks (Ramboll 2022).                                                                                                                                                                                                                                                  |
| Workers' rights                                           | The ISO 9001 certification of CBG shall be directed to improve its internal performance, particularly by involving, enhancing, and developing the skills of its employees. CBG has adopted and implements the IFC's PS2 Workforce and Working Conditions performance standard. GBC has a Workers Grievance Mechanism for direct employees and contractors.                                                                                                                                                                                                                                                                                                     |

| ESG category                                | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | According to the Labour Rights Index 2022 for Guinea (80.5/100), Guinea is the only country in Africa that is approaching decent work.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Gender and diversity                        | CBG has taken measures to increase women participation. Also CBG states to have invested in the development of income-generating activities, particularly for youth and women Launched in 2017 with a start-up fund of around US\$ 3m, this programme shall show positive results with an average increase in community income of over 100 %.                                                                                                                                                                                                                                                                           |
| Local value added and community development | CBG claims that in collaboration with local authorities, it has supported the creation of about ten youth-led microenterprises. Since 2010, these have led to the creation of nearly 3,000 direct and indirect jobs with a turnover of around US\$ 3m.                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Governance</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Legal compliance                            | Relevant mining and environmental licences are available. No indication of any violation of the law found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Management practices                        | CBG is certified to ISO 9001:2015. This certification shall demonstrate CBG's ongoing commitment to continuous improvement of its processes to meet the quality criteria required by its customers. CBG is ensuring that the obtained certificates are maintained from year to year.                                                                                                                                                                                                                                                                                                                                    |
| Transparency and reporting                  | CBG is audited annually with regard to ESG issues by independent 3 <sup>rd</sup> -party auditors who are contracted by IFC. The audit report are published on CBG's web page. CBG reports its tax payments to the government of Guinea. CBG's declarations are found on its web page. CBG, through its shareholding, is a Public/Private capital Company and must therefore enforce all the conventions and agreements in the fight against corruption. CBG has established a whistle blowing mechanism. However, the compliance officer is located in the structure of CBG.                                            |
| Business ethics                             | CBG has written a code of Ethics and Business Conduct that addresses relevant ESG issues. The Entity has developed and implemented an Anti-Corruption Code (last updated in 2021) that outlines all commitments to mitigate Corruption, respective training is conducted for employees. Guinea is not part of the CAHRAs list. With a score of 26 in Corruption Perception Index Guinea has Rank 141 out of 180 countries worldwide. Guinea is an EITI country since 2007. CBG is reporting to the EITI process in Guinea. There is no indication found of misalignments in the payments of CBG made to the government. |

Table 58. ESG features of the Sangarédi project, Guinea

#### 4.24.4 Further reading

ASI Certification Performance Standard: Provisional Certification (2023). [ASI Summary Audit Report Compagnie des Bauxites de Guinee - CBG Certificate 326 PS \(aluminium-stewardship.org\)](#) (accessed 11.03.2024)

CBG (2021): Rapport de développement durable 2021. <http://cbg-guinee.com/wp-content/themes/cbg/assets/assets/images/CBG%20-%20RAPPORT%20RDD%20-%20V8.pdf> (accessed 11.03.2024)

CBG (2024): Code of Conduct. <http://cbg-guinee.com/en/> (accessed 15.01.24)

International Renewable Energy Agency IRENA (2022). Renewable Energy Statistics 2022. [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jul/IRENA\\_Renewable\\_energy\\_statistics\\_2022.pdf?rev=8e3c22a36f964fa2ad8a50e0b4437870](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jul/IRENA_Renewable_energy_statistics_2022.pdf?rev=8e3c22a36f964fa2ad8a50e0b4437870)

Ramboll (2022) Monitoring & Audit. [http://cbg-guinee.com/en/publication\\_manager/monitoring-audit/](http://cbg-guinee.com/en/publication_manager/monitoring-audit/) (accessed 11.03.2024)



## 4.25 Songwe Hill REE carbonatite project (Malawi)

Information as of 02/2024

### 4.25.1 General project background

|                                 |                                                                                                                                                                                                  |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Neodymium, praseodymium, terbium, dysprosium                                                                                                                                                     |
| <b>Other commodities</b>        | Other REEs, gypsum                                                                                                                                                                               |
| <b>Location</b>                 | Phalombe, Malawi<br>15°41' S, 35°49' E, 600 – 1500 m.a.s.l.                                                                                                                                      |
| <b>License type</b>             | Retention licence RTL 0001/21 (25 km <sup>2</sup> , refers to 1 of 10 blocks totalling 250 km <sup>2</sup> ; valid until 06/2026)                                                                |
| <b>License owner / operator</b> | 100 % Mkango Resources Ltd. (public company)                                                                                                                                                     |
| <b>Contact</b>                  | 550 Burrard Street, Suite 2900<br>Vancouver, British Columbia V6C 0A3, Canada<br><a href="https://www.mkango.ca">https://www.mkango.ca</a><br><a href="mailto:will@mkango.ca">will@mkango.ca</a> |
| <b>Project status</b>           | Definitive Feasibility Study completed (07/2022)                                                                                                                                                 |
| <b>Production by 2030</b>       | Announced for 2025; a certain delay might be expected, but production by 2030 appears possible                                                                                                   |



Figure 44. Songwe Hill project location, Malawi

### 4.25.2 Economic assessment

#### General project background:

Historical exploration programmes were carried out at Songwe Hill in the late 1980s. The project is located within a carbonatite intrusion-breccia complex expressed as a steep-sided hill ~800 m in diameter. The principal lithologies that comprise the Songwe Hill complex are carbonatite, fenite and breccia, where REE mineralisation occurs, and phonolite. Mkango has proven REE mineralisation to a depth of 350 m below surface and suspects even more deep-seated ore. The company plans to produce a mixed rare earth carbonate (MREC) product to be shipped to its planned REE separation plant in Pulawy (Poland). Mining is scheduled to commence in 09/2025. The owner is seeking investment for the development of on- and off-site infrastructure as well as the construction of the mine and processing facilities.

#### Project description:

|                                 |                                                                                                                                                                                                  |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                | Carbonatite                                                                                                                                                                                      |
| NI 43-101 compliant reserves    | 18.2 Mt @ 1.16 % TREO (547 ppm $\text{Pr}_6\text{O}_{11}$ , 1,815 ppm $\text{Nd}_2\text{O}_3$ , 21 ppm $\text{Tb}_4\text{O}_7$ , 98 ppm $\text{Dy}_2\text{O}_3$ )                                |
| Share of global TREO reserves   | 0.2 % ( <i>USGS estimate global TREO reserves of 120 Mt</i> )                                                                                                                                    |
| NI 43-101-compliant resources   | 48.6 Mt @ 1.37 % TREO                                                                                                                                                                            |
| Waste to ore ratio              | 2.23                                                                                                                                                                                             |
| Annual production               | 1 Mt of ore, Ø 4,601 t TREO in MREC (recovery: 74 %)                                                                                                                                             |
| Share of global TREO production | 1.6 % ( <i>USGS estimate global TREO production of 280 kt</i> )                                                                                                                                  |
| Life of mine                    | 18 years                                                                                                                                                                                         |
| Investment required             | US\$ 311m (referring to initial development of mine and processing plant)                                                                                                                        |
| Net present value (NPV)         | US\$ 559m (assuming a 27 % discount applied to the forecasted value of the REE contained in the MREC, equivalent to a TREO basket price of US\$ 34,200/t and a 10 % discount rate on cash flows) |

#### Mining and processing:

- For the purposes of Mineral Resource definition, three lithological domains were identified in the Songwe Hill deposit: a carbonatite domain; a fenite domain; and a “mixed” domain consisting of breccia and/or finely intermixed carbonatite and fenite. The dominant REE-bearing minerals are synchysite and apatite, with minor florencite. The apatite is anomalously enriched in the heavy rare earth elements (HREE), compared to apatites in most carbonatite deposits.
- Conventional open pit mining will include drilling and blasting. Processing at Songwe Hill will comprise a concentrator plant and a hydrometallurgical plant and include crushing, milling, grinding, flotation, concentrate thickening and filtration as well as gangue leaching, solid-liquid separation and (radionuclide- and uranium-free) REE carbonate precipitation, respectively. Solid

gypsum is a by-product of hydrometallurgical processing and is considered for sale. The processing facilities are supposed to process 5,954 t of TREO within the first five years and 4,081 t TREO/a thereafter. Mkango expects TREO recovery of 74 % to MREC.

- Mkango points out that the Songwe Hill's MREC value is elevated due to high praseodymium (7.7 %), neodymium (25.1 %), terbium (0.2 %) and dysprosium (0.7 %) contents, which account for ~95 % (19.0 %, 65.1 %, 5.9 % and 5.2 %, respectively) of the MREC basket value. Mkango anticipated basket prices, which ranging between US\$ 23,700/t in 2022 and US\$ 46,010/t forecasted for 2035. The OPEX at Songwe Hill are expected to be US\$ 25,307/t TREO for the first five years of production and US\$ 30,100/t TREO for the life of mine. The costs are mainly contributed by reagents/consumables, mining and power to ~50 %, ~20 % and ~17 %, respectively.

#### **BGR assessment and comments:**

- The deposit is a medium-grade, medium-tonnage TREO project with relatively high ore value contributions from praseodymium, neodymium and heavy rare earth elements (HREE). The waste to ore ratio is relatively low due to the near-surface location of the mineralisation. The rather long life of mine (18 years) can be positive for the development of the region. Drilling to a maximum of ~350 m below surface has demonstrated the existence of mineralised carbonatite. The deposit remains open at depth. Together with the applied cut-off grade of 1.0 % TREO, Songwe Hill holds significant potential for reserve and resource upgrades.

- Synchysite and apatite are the main REE-minerals at Songwe Hill. However, there are no established large-scale processing routes for these minerals so far. It remains unclear whether the planned separation plant in Puławy in Poland, which is financially supported by ERMA, has the expertise to develop a commercial flowsheet. The project could benefit from Mkango's knowledge in recycling rare earth magnets in the UK.

- Mkango's revenue and NPV are based on REO basket prices of ~US\$ 34,000/t. Prices referring to Songwe Hill's concentrate basket were as low as US\$ 23,700/t in 2022. It is recommended to revise the basket price estimates. Even if the high REO price forecasts are not taken into account, both the OPEX for the first five operating years and the OPEX for the entire life of mine exceed the low 2022 REO basket prices, so that the project's economic viability is doubtful.

- Songwe Hill can be accessed from the urban centres via the national highways S144 and S145 (15 km distance), respectively. Four routing options consider road freight to the ports of Durban and Richards Bay (both in South Africa; >2,000 km) as well as to the ports of Beira and Nacala (both in Mozambique ~700 km). Possible rail connection to Nacala via Blantyre (~90 km East). Power demand for the mine operation is planned to be covered by grid and partly by

integrated thermal power, photovoltaic and Battery Energy Storage Solutions (BESS). Water is planned to be sourced from boreholes and process water ponds.

### 4.25.3 ESG assessment

Mkango Resources Ltd. reports relatively extensively on its ESG performance and intentions, e.g. through an ESG report in 2022. As part of this, and to fulfil the requirements of the DFS, numerous baseline studies have been undertaken to monitor the potential impacts of the proposed mining activities. However, these studies as well as the Environmental Social Health Impact Assessment (ESHIA) are not publicly available and could not be analysed for the ESG assessment. The project site is surrounded by riparian and wetland areas with critical habitats and has high flood risk, with two major floods in the last 10 years. Comprehensive risk and environmental (biodiversity) management is therefore required. The Songwe Hill project was part of several LCA studies, also due to a research co-operation between Mkango and e.g. the University of Exeter (UK). However, the results are partly contradictory and have led to discussions in the scientific community. This highlights the challenges of assessing the environmental impact of projects before they start, especially for the processing and refining phase where flowsheets and final products are not yet finalised.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Environmental management                                           | An Environmental, Social, Health and Management Plan was compiled for the project and the ESHIA has been approved by the Malawi Environmental Protection Agency. For most relevant environmental aspects, a monitoring plan has been developed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Efficient use of energy, renewable energy, GHG emissions reporting | Weng et al. (2016) calculated a very high global warming potential and a very high gross energy requirement, which was questioned in a response by Pell et al. (2017) with reference to inadmissible comparisons with other projects. An internal LCA assessment showed that the lowest global warming potential can be achieved by combining on-site acid regeneration with energy from hydropower and photovoltaics during off-peak periods. It is planned to cover the energy demand (~25 MW) by solar energy (three photovoltaic plants) supplemented by grid electricity (~75 % renewables, mainly bioenergy, 22 % oil, sufficient supply unclear) during the night and unfavourable conditions for photovoltaics. |
| Water management and consumption                                   | The project site is located in an area with low water stress, however with high riverine flood risk. Several seasonal streams flow into Mpoto Lagoon (~2 km north) that are not well defined and result in localised flooding (larger floods in 2015 and 2018). Mkango conducts an ongoing monitoring/assessment of surface and ground water quality and quantity. Adequate stormwater management will be needed.                                                                                                                                                                                                                                                                                                       |



| ESG category                                                                                                         | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pollution prevention                                                                                                 | The risk of acid mine drainage is low (low sulphide content, high buffer capacity related to geology). The handling of hydrochloric acid to be used for leaching of gangue (at pH4) and rare earths (at pH2) requires a responsible approach and acid regeneration must be operated in such a way that the acid is not lost into the gypsum filter cake. Th (339 ppm) and U (13 ppm) contents are relatively low compared to the global average of REE projects. Passive radon monitoring and a prospective radiological public safety assessment was developed as part of the ESHIA process and showed that for all potential receptors the contribution of the project (incl. radiation exposure from waste streams) during the operational period is less than the public dose limit of 1,000 $\mu\text{Sv/a}$ . |
| Air quality                                                                                                          | One of the main concerns of the surrounding communities is the dust pollution caused by the mining activities. The proposed Drill & Blast and Load & Haul mining methods as well as subsequent crushing and grinding bear the risk of dust generation, esp. during the dry season (Apr – Nov). Mkango conducted a dust fallout monitoring as a baseline study prior the mining activities, however, no information on mitigation measures are available.                                                                                                                                                                                                                                                                                                                                                            |
| Tailings management                                                                                                  | A TSF for ~20 Mt of tailings is required. Plans were conducted to comply with the relevant local and international pollution control regulations, national discharge standards and international best practices (Global Industry Standards for Tailings Management adopted for design and management of TSF). The leaching of radionuclides into the groundwater has been determined as insignificant according to a simplified one-dimensional numerical groundwater model. The increased risk of flooding has so far only been taken into account in the TSF Pond Water Management Philosophy.                                                                                                                                                                                                                    |
| Waste management                                                                                                     | A detailed waste management plan has been formulated as part of the ESHIA. Waste rock and ore below the cut-off grade will be separated to allow for possible reprocessing. Mkango has formulated a strategic plan to minimize waste through "Mine, Refine and Recycle", supported by investments in magnet recycling companies and own recycling initiatives.                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Hazardous materials management                                                                                       | Uranium will be removed from the leaching solution by ion exchange. However, no information is available on its disposal or on thorium in general. The total effective doses indicate that for an exposure to airborne radionuclides, the dose to members of the public will not exceed regulatory limits (i.e. <1,000 $\mu\text{Sv/a}$ ).                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Noise and vibration                                                                                                  | No information available. The proposed mining methods "Drill & Blast" and "Load & Haul" as well as the subsequent crushing and grinding have the potential to cause noise and vibrations to the neighbouring settlements (1-2 km).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Protected areas and biodiversity  | The proposed project area is surrounded by riparian and wetland areas, including critical habitats that need to be protected. A baseline study was conducted that assessed the potential impacts to wetlands and proposed mitigation and management plans.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | There are several bird species in the lagoon on the project site, two of which are on the IUCN Red List (one as endangered, one as vulnerable). Biodiversity monitoring has begun by conducting baseline studies, and flora and fauna conservation programmes have been announced.                                                                                                                                                                                 |
| Mine closure                                              | A Rehabilitation and Closure Plan was compiled as part of the ESHIA process in line with international standards (ICCM Tailings Management and Integrated Mine Closure Good Practice Guidelines; reference also to IFC Performance Standards and Equator Principles, which, however, do not contain specific requirements for mine closure). The estimated closure costs of US\$ 16.5 m are included in the CAPEX.                                                 |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Community health, safety and security                     | The project site is located in south-east Malawi near the border with Mozambique in a sparsely populated area. However, there are several farms and small villages close to the site that will be directly affected by the planned mining activities. Mkango has conducted an IFC-compliant ESHIA (including a health impact assessment); however, detailed results are not known.                                                                                 |
| Dialogue and engagement with communities and stakeholders | In-depth stakeholder engagement via an Informed Consultation and Participation process completed for the ESHIA. A Stakeholder Engagement Programme is in place that includes e.g. a grievance mechanism.                                                                                                                                                                                                                                                           |
| Land acquisition and involuntary resettlement             | The implementation of the project requires the resettlement of communities and the relocation of cultural assets and graves. Compliance of the Resettlement Action Plan with ISO PS 5 and the establishment of a resettlement working group made up of representatives of the affected communities has been announced.                                                                                                                                             |
| Occupational health & safety management                   | An OHS management system is in place with the aim of a zero-harm workplace, supported by risk assessments and internal training. Further information is not available.                                                                                                                                                                                                                                                                                             |
| Workers' rights                                           | Malawi scores 68/100 in the Labour Rights Index. Commitment of Mkango to ILO's Core Conventions. No indication of non-compliance with fundamental workers' rights on the project site found.                                                                                                                                                                                                                                                                       |
| Gender and diversity                                      | Commitment to a strict anti-discrimination policy, no further information available.                                                                                                                                                                                                                                                                                                                                                                               |
| Local value added and community development               | In its ESG report, Mkango states that the project will create new supply chains. In conjunction with taxes and royalties, this has the potential to increase GDP by up to 2 %, according to Mkango. CSR Initiatives as education/school support programmes are already being implemented. Infrastructure, especially roads and bridges, could benefit from mining activities. Seven new water boreholes with hand pumps have been installed for local communities. |



| ESG category               | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Governance</b>          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Legal compliance           | Mkango has a retention license for the planned mine site, a mining licence has not yet been issued. No evidence of legal violations found.                                                                                                                                                                                                                                                                                                                                                                                      |
| Management practices       | Canadian based Mkango Resources Ltd. holds several subsidiaries for exploration, refining and recycling in Malawi, UK, Poland and Germany, some of which are also in British Virgin Islands. No indication of poor management practices found.                                                                                                                                                                                                                                                                                  |
| Transparency and reporting | Mkango Resources Ltd. (TSX-V/AIM: MKA) is listed on the UK and Canadian stock exchanges and as such provides related information for investors. Mkango published an ESG report in accordance with the Global Reporting Initiative (GRI) Standards “Core” option. Commitment to several disclosure standards and frameworks, including the United Nations Global Compact, Sustainability Accounting Standards, Board Metals and Mining Sustainability Accounting Standard, and the Mining Local Procurement Reporting Mechanism. |
| Business ethics            | Malawi scores 34/100 in the Corruption Perception Index. Mkango has an anti-corruption and bribery policy in place and supports EITI Malawi. A Supplier Code of Conduct has been implemented.                                                                                                                                                                                                                                                                                                                                   |

Table 59. ESG features of the Songwe Hill project, Malawi

#### 4.25.4 Infrastructure assessment

##### Potential Investment Needs:

- Road Infrastructure: Further investments may be necessary to upgrade dirt tracks
- Railway Enhancements: The project site is not connected to the rail network, cargo transportation is done via roads. Investments can be made to connect the project site with the existing rail network.
- Renewable Energy Ventures: Investments should be made to increase energy generation from renewable energy sources, e.g. photovoltaic and Battery Energy Storage Solutions (BESS) to decrease dependencies from power grid and diesel generators.
- Water Supply: Pit dewatering infrastructure and waste dump footprint and waterways requires US\$ 4m of investment.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | The project is located in a rural and undeveloped area. An Airtel communication tower was installed in 2021 to the west of the project site on a hill in close proximity to the proposed location of the processing plant. This tower has been used to date with good results. Mkango will provide an integrated information system with the latest operating |

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             | systems, enabling effective telephonic and digital communication. The development costs for on-site infrastructure are estimated at US\$ 12.5m.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Transport   | The project site can be reached via national highways S145 and S146. At Migowi, the S145 passes within 15 km of Songwe Hill. The Malawi Roads Authority has upgraded an existing government road from nearby Migowi to the Songwe Hill project site. To date, 12 km of an existing 15 km government dirt track have been upgraded and widened into an all-weather gravel road, and new reinforced concrete culverts, embankments and bridges suitable for 20 t trucks have been installed. There are no insurmountable height restrictions on the routes that would preclude abnormal load travel.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Airport     | Chileka International Airport is the second largest international and regional airport situated 13 km northwest of Blantyre with a runway of 2.325 km and 778 m elevation. It's the closest airport to the commercial centre of Blantyre. Payloads of planes can be up to 60 t. Cargo weighs less than 3 t, dimensions less than 3.0 m (length), 2.0 m (width) and 1.50 m (height) can be airfreighted. Commercial flights to five different destinations (Kamuzu Intl, Johannesburg Intl, Dar es Salaam, Beira and Addis Ababa Bole Intl) with two airlines, namely, Ethiopian Airlines and South African Airways.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Rail access | A rail network of 797 km total length exists with 706 km in operation. There are two rail routes in Malawi, a 696 km long route from the Border Station at Marka (the border post with Mozambique) to Mchinji (the border post with Zambia), and a 101 km long route from Nkaya to Nayuchi (the border post with Mozambique). Both are for cargo and passengers. The narrow gauge single line railway is publicly owned. The Port of Nacala (Mozambique) is connected with Malawi by a 931 km railway.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Port        | Four ports are located around the project site, the ports of Durban and Richards Bay (both South Africa) and the ports of Beira and Nacal (both Mozambique). The Port of Durban (~2,300 km south of Songwe Hill) is Africa's biggest container port in terms of capacity and handles an average of 83,000 containers each month. The Port of Richards Bay (~2,150 km south of Songwe Hill) has excellent road connections to the north and south, as well as to inland regions in the west and is South Africa's leading port in terms of cargo volumes handled. The Port of Beira links directly, by road or by rail, the main markets of the Southern African hinterland (Zimbabwe, Botswana, Malawi, Zambia and the Democratic Republic of the Congo) to the marketing and routes of international trade. The facilities include a 645 m long quay with a depth of 12 m. The terminal has four container gantry cranes, two of which have the capacity to carry 65 t. The terminal can store more than 10,000 TEUs (twenty-foot equivalent units) and has 148 electricity connection points for refrigerated containers. Currently, the terminal can handle 300,000 TEUs a year. The Port of Nacala is the deepest port in Southern Africa. The natural deep harbour serves northern areas of Mozambique, as well as the landlocked Malawi. The infrastructure belongs to the Mozambican government, which is responsible for its administration through the public-private joint venture company Integrated Northern Logistical Corridor Society (CLIN). CLIN was created to administer licences for cargo terminals in addition to passenger terminals. There are four general cargo berths and one container berth. |
| Energy      | Electricity required for the Songwe project will be supplied through a 24 MW solar facility that will be supplemented with grid power, which is largely from hydroelectric sources. Mkango is also considering thermal and wind power to further enhance and diversify the renewable energy mix. Electricity production costs of onshore wind turbines                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

|                       | (specific plant costs of US\$ 1400/kW to US\$ 2000/kW) are between US\$ 0.04/kWh and US\$ 0.09/kWh (2021).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |                                |                   |                                |                |        |        |    |                 |      |      |    |                       |      |      |    |                    |      |      |    |                  |      |      |    |                 |       |       |    |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------------------|-------------------|--------------------------------|----------------|--------|--------|----|-----------------|------|------|----|-----------------------|------|------|----|--------------------|------|------|----|------------------|------|------|----|-----------------|-------|-------|----|
| GHG emission          | <p>As basis for the calculation of emissions, it has been assumed that the grid will have one outage a week for 8 h, the essential load will be capped at a constant 7.2 MW, 90 % of the generator capacity as well as the Infrastructure equipment will have a 0.65 diversity factor and the grid will be available three months before the concentrator is commissioned. A reduction in emissions includes indirect emissions from the lower grid energy consumption as well as reduced fuel consumption from backup diesel generators, currently estimated to generate 2,995 MWh for the grid-only option vs. 1,953 MWh for the grid-with-PV option due to an allowance of 416 h of grid outages per year. This would decrease the diesel purchase from 735,501 l/a to 493,501 l/a, which is a 33 % saving.</p> <table> <tr> <th>Emissions</th> <th>Grid Only (t/a)</th> <th>Grid and PV (t/a)</th> <th>% Saving Compared to grid only</th> </tr> <tr> <td>Carbon Dioxide</td> <td>53,411</td> <td>34,932</td> <td>35</td> </tr> <tr> <td>Carbon Monoxide</td> <td>5.06</td> <td>3.39</td> <td>33</td> </tr> <tr> <td>Unburned Hydrocarbons</td> <td>0.41</td> <td>0.27</td> <td>34</td> </tr> <tr> <td>Particulate Matter</td> <td>0.78</td> <td>0.52</td> <td>33</td> </tr> <tr> <td>Sulphur Dioxides</td> <td>4.83</td> <td>3.23</td> <td>33</td> </tr> <tr> <td>Nitrogen Oxides</td> <td>19.30</td> <td>12.93</td> <td>33</td> </tr> </table> | Emissions         | Grid Only (t/a)                | Grid and PV (t/a) | % Saving Compared to grid only | Carbon Dioxide | 53,411 | 34,932 | 35 | Carbon Monoxide | 5.06 | 3.39 | 33 | Unburned Hydrocarbons | 0.41 | 0.27 | 34 | Particulate Matter | 0.78 | 0.52 | 33 | Sulphur Dioxides | 4.83 | 3.23 | 33 | Nitrogen Oxides | 19.30 | 12.93 | 33 |
| Emissions             | Grid Only (t/a)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Grid and PV (t/a) | % Saving Compared to grid only |                   |                                |                |        |        |    |                 |      |      |    |                       |      |      |    |                    |      |      |    |                  |      |      |    |                 |       |       |    |
| Carbon Dioxide        | 53,411                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 34,932            | 35                             |                   |                                |                |        |        |    |                 |      |      |    |                       |      |      |    |                    |      |      |    |                  |      |      |    |                 |       |       |    |
| Carbon Monoxide       | 5.06                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3.39              | 33                             |                   |                                |                |        |        |    |                 |      |      |    |                       |      |      |    |                    |      |      |    |                  |      |      |    |                 |       |       |    |
| Unburned Hydrocarbons | 0.41                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0.27              | 34                             |                   |                                |                |        |        |    |                 |      |      |    |                       |      |      |    |                    |      |      |    |                  |      |      |    |                 |       |       |    |
| Particulate Matter    | 0.78                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0.52              | 33                             |                   |                                |                |        |        |    |                 |      |      |    |                       |      |      |    |                    |      |      |    |                  |      |      |    |                 |       |       |    |
| Sulphur Dioxides      | 4.83                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3.23              | 33                             |                   |                                |                |        |        |    |                 |      |      |    |                       |      |      |    |                    |      |      |    |                  |      |      |    |                 |       |       |    |
| Nitrogen Oxides       | 19.30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 12.93             | 33                             |                   |                                |                |        |        |    |                 |      |      |    |                       |      |      |    |                    |      |      |    |                  |      |      |    |                 |       |       |    |
| Water                 | Water for processing and potable water use is expected to be drawn from groundwater. Water is supplied via raw water and process water ponds to the west of the plant. No drainage or sewage system. A 45 m³/h containerised sewage treatment plant will be provided north of the main plant terrace for the treatment and disposal of the sewage generated by the process plant and the mining operations. Included in the development costs for on-site infrastructure, water management are estimated at US\$ 4m.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                                |                   |                                |                |        |        |    |                 |      |      |    |                       |      |      |    |                    |      |      |    |                  |      |      |    |                 |       |       |    |

Table 60. Infrastructure assessment of Songwe Hill project, Malawi

#### 4.25.5 Further reading

Mkango (2022): Environmental, Social and Governance Report.

[https://mkango.ca/site/assets/files/4152/mkango\\_esg\\_report\\_web12-11-23.pdf](https://mkango.ca/site/assets/files/4152/mkango_esg_report_web12-11-23.pdf) (accessed 28.02.24).

Mkango (2023a): Mkango Resources – Rare Earths and Technology for the Green Revolution – Presentation. <https://assets.lsegissuerservices.com/original-cac2898d-603b-4b3a-bef8-44c313c667fd.pdf> (accessed 28.02.24).

Mkango (2023b): Sustainably Sourced Rare Earths for the Green Transition – Corporate Presentation.

[https://mkango.ca/site/assets/files/4952/mkango\\_corporation\\_presentation\\_oct\\_2023\\_website\\_-\\_20.pdf](https://mkango.ca/site/assets/files/4952/mkango_corporation_presentation_oct_2023_website_-_20.pdf) (accessed 28.02.24).

Pell, R., Wall, F., Yan, X., & Bailey, G. (2017): Response to 'Assessing the energy requirements and global warming potential of the production of rare earth elements'. Journal of Cleaner Production, 162, 791-794. <https://doi.org/10.1016/j.jclepro.2017.06.059>

Senet (2022): NI 43-101 Technical report on the Songwe Hill rare earth element project in Malawi. <https://www.sedarplus.ca/csa-party/viewInstance/resource.html?node=W7714&drmKey=f3e41dfbb8534294&dr=ss7595ff59c14c070b99b55c2f84d9711c9865d50e51f238e348390574ffa9bd5dec5534fd7049089b64b5e3afdd6d2739ux&id=0c11f8b7998bcd9698821e9ab53bfd126d6a6e4b6e6a0a85> (accessed 28.02.24).

Weng, Z., Haque, N., Mudd, G. M., & Jowitt, S. M. (2016): Assessing the energy requirements and global warming potential of the production of rare earth elements. Journal of cleaner production, 139, 1282-1297. <https://doi.org/10.1016/j.jclepro.2016.08.132>

## 4.26 Steelpoortdrift titanomagnetite V project (South Africa)

Information as of 11/2023

### 4.26.1 General project background

|                                 |                                                                                                                                                                                               |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Vanadium                                                                                                                                                                                      |
| <b>Other commodities</b>        | Titanium, iron ore                                                                                                                                                                            |
| <b>Location</b>                 | Bushveld Complex, Limpopo province, South Africa<br>24°51' S, 29°59' E, 900 – 1,000 m.a.s.l.                                                                                                  |
| <b>License type</b>             | Mining right (LP30/5/2/2/1/10095 MR), valid until September 2048                                                                                                                              |
| <b>License owner / operator</b> | Vanadium Resources (73.95%), BBBEE (26.05%)                                                                                                                                                   |
| <b>Contact</b>                  | Suite 7, 63 Shepperton Road, Victoria Park,<br>WA 6100 Australia<br><a href="https://www.vr8.global">https://www.vr8.global</a><br><a href="mailto:contact@vr8.global">contact@vr8.global</a> |
| <b>Project status</b>           | Feasibility complete                                                                                                                                                                          |
| <b>Production by 2030</b>       | Announced for 2025; a certain delay might be expected, but production by 2030 appears possible                                                                                                |

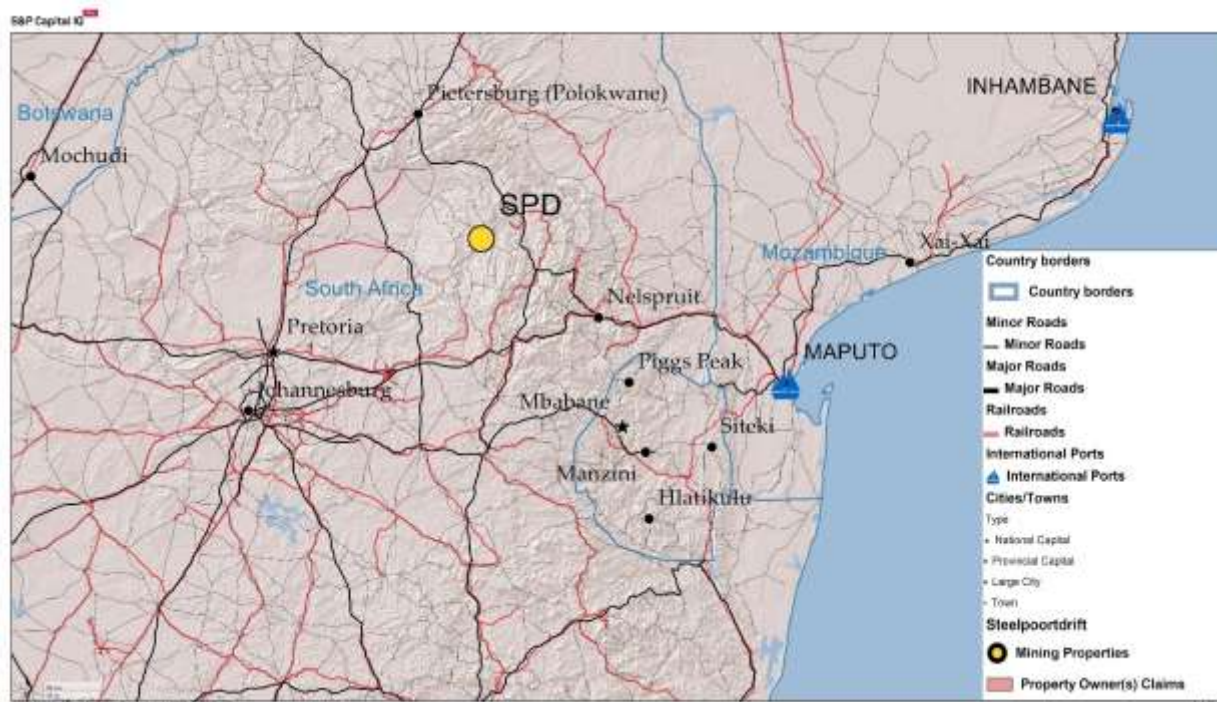


Figure 45. Steelpoortdrift (SPD) project location, South Africa

## 4.26.2 Economic assessment

### General project background:

Vanadium Technology carried out historical exploration activities including drilling and sampling between 1996 and 2006. Recent work by Vanadium Resources (formerly Tando) since 2018 includes remote sensing, helicopter and ground magnetics and geotechnical drilling. The project is located in the Bushveld Igneous Complex. The vanadium mineralisation is hosted in vanadiferous titanomagnetite layers, which occur at the same stratigraphic level across the entire complex and can be traced for almost 400 km. It is located close to the contact zone between the Upper Zone and Main Zone of the Bushveld Complex and hosted in three zones (Upper, Intermediate and Lower Magnetite Zones), which dip shallowly at 10-12° to the west. Phase 1 (year 1-4) involves open pit mining of an initial 1.6 Mt/a of vanadium ore at an average head grade of 0.83 %  $V_2O_5$ , the primary treatment of ROM through an onsite concentrator, secondary treatment of 0.72 Mt/a of concentrate through a conventional salt roast leach plant and the final sale of ~10.7 kt/a vanadium flake product at a grade of >98 %. Phase 2 (from year 5 to the end of mine life), ore production and processing will increase to 3.5 Mt/a at an average head grade of 0.71 %  $V_2O_5$ , increasing concentrate production to 1.25 Mt/a and 21 kt/a final product.

### Project description:

|                                               |                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                              | Orthomagmatic vanadiferous titanomagnetite                                                                                                                                                                                                                                                                                                                               |
| JORC compliant reserves                       | 77 Mt @ 0.72 % $V_2O_5$                                                                                                                                                                                                                                                                                                                                                  |
| Share of global vanadium reserves             | 2.1 % (USGS estimate global V reserves of 26 Mt)                                                                                                                                                                                                                                                                                                                         |
| JORC compliant resources                      | 680.13 Mt @ 0.7 % $V_2O_5$ , 22.76 % $Fe_2O$                                                                                                                                                                                                                                                                                                                             |
| Share of global vanadium resources            | 7.5 % (USGS estimate global V resources of 63 Mt)                                                                                                                                                                                                                                                                                                                        |
| Waste to ore ratio (whole orebody)            | 0.88 for 83.46 Mt                                                                                                                                                                                                                                                                                                                                                        |
| Annual production                             | Phase 1, year 1-4: 1.6 Mt of ore, 10.7 kt vanadium flake (>98 %)<br>Phase 2, >year 5: 3.5 Mt of ore, 21 kt vanadium flake (>98 %)                                                                                                                                                                                                                                        |
| Life of mine                                  | 25 years                                                                                                                                                                                                                                                                                                                                                                 |
| Investment required                           | US\$ 211m (for phase 1; mine, concentrator, leach plant)                                                                                                                                                                                                                                                                                                                 |
| Net present value (NPV)                       | US\$ 1.2bn (based on $V_2O_5$ price of US\$ 20.95/kg and a discount rate of 7.5 %)                                                                                                                                                                                                                                                                                       |
| Share of global vanadium production (phase 1) | 10.5 % (phase 1, recovery: 82.4 %)<br>(BGR estimates a global vanadium production of 102,000 t (primary and co-production))                                                                                                                                                                                                                                              |
| Value addition potential                      | Potential for additional revenue streams include a residual vanadium recovery plant as well as the production of additional products ( $V_2O_3$ , ferrovanadium, $TiO_2$ , ilmenite) and potential vertical integration opportunities such as the production of vanadium electrolyte for vanadium redox-flow batteries, battery manufacture and solar energy generation. |



**Mining and processing:**

- Conventional open pit methods employing drilling, blasting, and hauling at three pits. The mining plan for phase 1 and 2 comprises a production of 1.6 Mtpa and 3.5 Mtpa respectively, with an overall very low average waste to ore ratio of 0.88.
- Vanadium is concentrated via crushing, milling and magnetic separation to produce a final vanadium concentrate at 2.08-2.16 %  $V_2O_5$ . Testwork for phase 1 yielded a concentrate grading  $>2\%$   $V_2O_5$  at  $V_2O_5$  recoveries ranging from 95 % to 97 %. Trucks then haul the concentrate to the salt roast leach plant 23 km away for final processing, which comprises kiln roasting, leaching, desilication, AMV precipitation, flash drying and  $V_2O_5$  production. Pilot plant test work yielded an average global recovery of 82.4 % (concentrator and salt roast leach plant).
- The operating expenditures are given at US\$ 7.14/kg of final product ( $>98\%$   $V_2O_5$ ). This is within an expectable range for a primary vanadium producing operation.

**BGR assessment and comments:**

- The deposit is a medium-grade, high-tonnage operation with a relatively low overall waste to ore ratio of 0.88. The relatively long life of mine (25 years) is positive for the further development of the region. Additional life of mine of up to 67 years is possible with the readily available resource in the designed open pits.
- Short or long-term vanadium price fluctuations may be relevant. The company assumes a vanadium flake price of US\$ 20.95/kg ( $V_2O_5$  flake, 98 %). Considering the average vanadium price of US\$ 18.30/kg over the past 5 years (2019 until present), price assumption is rather high, we recommend a more conservative approach of  $<US\$ 20/kg$ .
- With vanadium as the only commodity, the low-grade mining project could potentially face difficulties to profitably extract the complete resource, when vanadium prices decline, as the waste to ore ratio is increasing over time (year 1-4: 0.28; year 5-25: 0.93), and hence operating costs are also increasing.
- The project is located in a well-established mining jurisdiction and existing chrome and platinum mining and smelting district, with relevant infrastructure including high-voltage power lines and substations, rail sidings, sealed roads, water resources and support businesses and skilled workforce already established in the region. Current plans envisage hauling of the concentrate to the salt roast leach plant by trucks. However, the company is investigating the potential to use a rope conveyor to cover the distance. This would lower operating costs as well as emissions and impact on local communities.

### 4.26.3 ESG assessment

The level of publicly available project information is good. For the purpose of DFS level reporting, ESG aspects meet the requirements, no major ESG issues were identified that would preclude responsible investment. Environmental risks are considered low, however, a number of baseline studies are ongoing and various licenses are currently under application with approval expected H1/2024. While there are no recorded incidents between the company and local stakeholders, there is potential for conflict around water use as the area is subject to high water stress.

| ESG issue                                                          | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Environmental Management                                           | The project holds an Environmental Management Programme (EMPr) approved in terms of the Mineral and Petroleum Resources Development Act (Act No. 28 of 2002, MPRDA) and the National Environment Management: Waste Act (Act No. 59 of 2008, NEMWA) which formed part of the 2014 Mining Right Application.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Efficient use of energy, renewable energy, GHG emissions reporting | <p>No information on scope 1 and scope 2 emissions is available.</p> <p>Mining operations and concentrator: A PV solar farm is located along the southern boundary of the mine site to provide power for the mining operations and concentrator (5 MW AC, 6 MWpeak DC and 1 MW/4 MWh vanadium redox-flow battery storage). This will enable an annual reduction of 34 % (14,192 t CO<sub>2</sub>) of Scope 2 emissions compared to grid-only. Back-up power is from connection to grid, with coal as the mainstay (70 %) of the South African energy system.</p> <p>Salt roast leach plant: Power will be obtained from grid. Kadoma (current owners of adjacent property) plans exist to develop an adjacent utility scale PV plant to provide power to the plant and surrounding mines. Plans include the construction of a modular setup of 2 MW peak each.</p>                                                                                                                                                                                                                                                                                                                                                                               |
| Water management and consumption                                   | <p>The project is located within an area of high water stress; the location within an existing mining area could increase competition for water resources. Medium to high riverine flood risk.</p> <p>Concentrator: Process water will be obtained from the existing De Hoop dam water distribution system, which consists of water distribution lines and reservoirs situated on the mine site boundary. In addition, water will be recirculated and returned to the concentrator from pit dewatering, tailings and run-off. The required water top-up is estimated at between 23,100 – 24,200 m<sup>3</sup> per month depending on the season.</p> <p>Salt roast leach plant: Raw water will be obtained via existing connection to the Olifants River Water Management scheme via a dedicated raw water pipeline on the Lebalelo Water User Association pipeline. Water will also be recirculated and returned from tailings and run-off. The required process water top-up is estimated at between 19,500 – 24,000 m<sup>3</sup> per month depending on the season.</p> <p>Kadoma (current owners of adjacent property) plan construction of a water-treatment facility to serve plant and other existing mining operations in the area.</p> |



| ESG issue                                                 | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pollution prevention                                      | No information available. Assessments regarding pollutants in the form of gaseous emissions and pollution of water courses ongoing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Air quality                                               | No information on expected emissions from operations available. At the date of DFS, baseline studies were still ongoing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Tailings management                                       | <p>Tailings will be stored in a tailings storage facility for three years prior to them being returned to the mined out open pits as part of the rehabilitation process.</p> <p>Concentrator: dry stacking method with Class D liner. Tailings eventually to be backfilled into open pit, thus no capping required. Site selected outside the ultimate pits and at 100 m buffer from the Magagamahubedu river. The dam failure consequence classification assigned to the concentrator plant tailings storage facility is <i>significant to high</i>.</p> <p>Salt roast leach plant: dry stacking method with Class C barrier system Filtered cake, classified as Type 3 waste. Capping solution designed in accordance to the Minimum Requirements for Waste Disposals by the Dept. of Water Affairs. Site selection constrained by the identification of cultural heritage artefacts in the nearby erosion channels. The consequence classification assigned to the salt roast leach plant tailings storage facility is <i>significant to high</i>.</p> |
| Waste management                                          | Two waste rock dumps to store waste rock prior to rehabilitation back into pit. No information available on further waste management policies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Hazardous materials management                            | The metallurgical processes used in extracting vanadium can release toxic elements into the environment. There is no information available on company management of hazardous materials.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Noise and vibration                                       | No information available. Baseline studies ongoing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Protected areas and biodiversity                          | The project is not located in or close to a key biodiversity area. The site is within an established mining and smelting district; expected biodiversity impacts are low.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Mine closure                                              | No information available on liabilities and mine closure plan.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Community health, safety and security                     | Local town of Steelpoort (1,000 inhabitants) to the north as well as a number of villages and towns immediately to the south of the proposed mine site. Appropriate buffer zone to be established between mining area and local community to avoid encroachment of mine. No further detailed information available on expected impact on local population.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Dialogue and engagement with communities and stakeholders | Social and Labour Plan linked to the mining right in place with application for amendments pending. Continuous engagement and consultation with local communities ongoing. No information on past conflicts between local stakeholders and the company.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Land acquisition and involuntary resettlement             | The project is within a Special Economic Zone (SEZ) around Steelpoort and within an established mining area. A rezoning application for individual areas on the property has been submitted for review and approval is pending. Mining and concentrator personnel during the early construction period to be housed in existing school buildings located on mine site following relocation of existing school. The acquisition of 135 ha for the salt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| ESG issue                                     | Assessment                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                               | roast leach plant is pending. Baseline studies underway for land use and land capability at time of DFS. A heritage impact assessment identified sites of cultural significance, with potential negative impacts from mining operations to be mitigated by appropriate action. No information on past grievances between local stakeholders and the company. |
| Occupational health & safety management (OHS) | No information available on planned OHS measures on site, however costs are provided at a head office/operational readiness level and have been included in DFS. Work to commence in 2024.                                                                                                                                                                   |
| Workers' rights                               | South Africa scores 79/100 (reasonable access to decent work) in the Labour Rights Index. Social and labour plan approved with amendments submitted to regulators and pending.                                                                                                                                                                               |
| Gender and diversity                          | No information available.                                                                                                                                                                                                                                                                                                                                    |
| Local value added and community development   | Local value contribution considered generally high. Suitable skills will be sourced from the local community to support the mining, processing, engineering and administrative function where appropriate.                                                                                                                                                   |
| <b>Governance</b>                             |                                                                                                                                                                                                                                                                                                                                                              |
| Legal compliance                              | Relevant environmental authorisations and water use licence applications pending.                                                                                                                                                                                                                                                                            |
| Management practices                          | Little to no information available on ESG policies and management.                                                                                                                                                                                                                                                                                           |
| Transparency and reporting                    | Listed on the ASX; extensive information for investors, reports on financial accounts and shareholder structure available                                                                                                                                                                                                                                    |
| Business ethics                               | South Africa scores 41/100 in the corruption perception index; South Africa is not an EITI country. No indication of unethical practices. Financial accounts according to stock listing requirements; company with registered office in Perth, Western Australia.                                                                                            |

Table 61. ESG features of Steelpoortdrift project, South Africa

#### 4.26.4 Further reading

Definite Feasibility Study (2022): Vanadium Resources – Steelpoortdrift Vanadium Project. <https://vr8.global/wp-content/uploads/2023/11/DFS-delivers-A1.9Bn-NPV-Confirming-World-Class-Project.pdf> (accessed 28.11.2023)

Updated Mineral Resource and Ore reserve for the Steelpoortdrift Vanadium Project (2022). <https://vr8.global/wp-content/uploads/2023/11/VR8-Updates-Mineral-Resource-and-Ore-Reserve.pdf> (accessed 28.11.2023)

## 4.27 Toliara Ti-REE heavy mineral sands project (Madagascar)

Information as of 11/2023

### 4.27.1 General project background

|                                 |                                                                                                                                                                                                               |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Titanium (ilmenite, rutile) Zirconium (zircon)                                                                                                                                                                |
| <b>Other commodities</b>        | REE (monazite, garnet); not yet authorised                                                                                                                                                                    |
| <b>Location</b>                 | Toliara, Madagascar<br>22°58' S, 43°41' E, 100 – 350 m.a.s.l.                                                                                                                                                 |
| <b>License type</b>             | Mining License PE 37242 (125.4 km <sup>2</sup> )                                                                                                                                                              |
| <b>License owner / operator</b> | Base Resources Ltd. (public company)                                                                                                                                                                          |
| <b>Contact</b>                  | 46 Colin Street, Level 3<br>West Perth, Western Australia 6005, Australia<br><a href="https://baseresources.com.au/info@baseresources.com.au">https://baseresources.com.au/<br/>info@baseresources.com.au</a> |
| <b>Project status</b>           | Feasibility complete (Ti, Zr), prefeas. underway (REE)                                                                                                                                                        |
| <b>Production by 2030</b>       | Yes, announced for 2027                                                                                                                                                                                       |



Figure 46. Toliara project location, Madagascar

### 4.27.2 Economic assessment

#### General project background:

The Toliara Project is based on the world class Ranobe heavy mineral sands (HMS) deposit. The area was first explored in 1995 and acquired by the current owner, Base Resources in 2018. The deposit comprises of ca. 20 km long, 1.5 to 4.5 km wide and 3 m to 60 m in thick mineralisation, situated immediately west of a prominent N-S-trending escarpment. The HMS, including ilmenite (Ilm), rutile (Rt), leucoxene (Leuc), zircon (Zrn), monazite (Mon) and garnet (Grn), extend from the surface and will be mined via dredge with subsequent wet concentrator plants (WCPs) and mineral separation plant (MSP). The Toliara Project will be implemented in two stages, with stage 2 production (25 Mt) commencing ~4 years after stage 1 completion (13 Mt). At the moment it is suspended due to negation of fiscal terms according to the company, or on ground opposition (according to news reports). If the government-imposed suspension is lifted and fiscal terms are agreed, an 11-month early works program is required to reach final investment decision. The Company is primarily seeking investment for pre-FID work and subsequent construction and commissioning (heavy equipment, dry mining unit, WCP, MSP as well as on- and off-site infrastructure).

#### Project description:

|                                     |                                                                                                                   |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                    | Placer                                                                                                            |
| JORC compliant reserves             | 904 Mt @ 4.4 % Ilm, 0.06 % Rt, 0.06 % Leuc, 0.4 % Zrn                                                             |
| Share of global ilmenite reserves   | 6.2 % ( <i>USGS estimate global ilmenite reserves of 650 Mt</i> )                                                 |
| Share of global rutile reserves     | 1.1 % ( <i>USGS estimate global rutile reserves of 49 Mt</i> )                                                    |
| JORC compliant resources            | 2,580 Mt @ 3.1 % Ilm, 0.04 % Rt, 0.04 % Leuc, 0.3 % Zrn, 0.1 % Mon, 0.1 % Grn                                     |
| Annual production                   | 25 Mt HMS (stage 2), containing 960 kt Ilm (recovery: 90 %), 8 kt Rt (recovery: 50 %), 66 kt Zrn (recovery: 77 %) |
| Life of mine                        | 38 years                                                                                                          |
| Investment required                 | US\$ 657m (US\$ 520m for stage 1 and US\$ 137m for stage 2)                                                       |
| Net Present Value (NPV; Post-tax)   | US\$ 1bn ( <i>based on a discount rate of 10 %</i> )                                                              |
| Share of global ilmenite production | 10.8 % ( <i>USGS estimate global ilmenite production of 8.9 Mt</i> )                                              |
| Share of global rutile production   | 1.4 % ( <i>USGS estimate global rutile production of 0.59 Mt</i> )                                                |

#### Mining and processing:

- Stage 1 mining methods include a dry mining unit fed by bulldozers with some excavator assistance. Sand from the dry mining unit passes a 4 mm screen with the <4 mm fraction fed to the WCP (throughput capacity of 1,750 t/h). The heavy mineral concentrate is then fed to the mineral separation plant, which produces ilmenite, zircon and rutile splits (150 t/h). Four years after stage 1 mining commences, stage 2 production commences, including a second dry mining unit, a second WCP (1,750 t/h) and upgrading the mineral separation plant to 220 t/h.



- Initially, the WCPs rejects oversize material. Subsequently, the ore feed is passed over progressive stages of gravity spirals, after being deslimed (separated from clay), the feed is separated into the heavy mineral concentrate (HMC) and tailings (silicates like quartz and feldspar). The HMC is pumped to the MSP, where it is stockpiled prior to further processing. The HMC consists of Ilm, Rt, Zrn, Leuc, Mon and Grn, other heavy minerals and a small amount of silicates.
- The mineral separation plant combines wet and dry magnetic separation as well as gravity and electrostatic circuits to separate the heavy mineral concentrates from non-valuable minerals (e.g., quartz and feldspar) and to produce final concentrates of Ilm, Rt and Zrn.
- The life of mine cash operating expenditures (incl. 4 % royalties) are given at US\$ 88/t of finished product and face a projected life of mine revenue of US\$ 306/t.
- Base Resources plans to negotiate offtake agreements right after the final investment decision.

### **BGR assessment and comments:**

- The deposit is a medium-grade, high-tonnage, surface operation. The long life of mine (38 years) can be positive for the development of the region. So far, only four of five top sand units have been considered for the mineral resource estimate. The fifth and deepest unit is the most voluminous and not yet included in the estimate. Currently, the company works on a prefeasibility study, which focusses on the REE-bearing minerals monazite and garnet. If the government approves their extraction and processing, this should have a positive impact on the project profitability.
- The project is located some 50 km north of the regional capital and international port of Toliara. Currently, the project site is only connected by roads inadequate for product transport. Base resources plans the construction of a new 45 km long, sealed road, including a new 630 m bridge over the Fiherenana River. Water is planned to be sourced from ground water (9 boreholes at stage 2 referring to 972 m<sup>3</sup>/hour) within the mining permit area. Due to the limited and unreliable grid power in the Toliara Region, Base Resources plans to self-supply the electrical power. At the mine site, the required power is 24 MW during stage 2 and might be produced via a hybrid of heavy fuel and oil as well as solar and a battery storage system. At the export facility, the power will be self-generated using diesel generators with a small contribution from solar power. The export facility at the port of Toliara (Batterie Beach) will include a storage shed for 135 kt of Ilm, 10 kt Rt, with a separate shed to store 17 kt of Zrn. A 550 m long jetty with pipe conveyor and fixed ship loader will load vessels (up to 68 kt), moored on a multi-buoy mooring berth.

### 4.27.3 ESG assessment

Project at an early planning stage, information on some ESG impacts of the project is still in a preliminary stage. Apparently good management practice at Base Resources Kwale operation in Kenya, which is comparable to the Toliara project. However, reports of conflicts existing on environmental concerns, displacement, and corruption dating back to 2019 and are reported as the reason for the suspension of on-ground activities. No information available, if conflicts are solved or persisting. Detailed verification on the ground highly recommended.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                |
| Environmental management                                           | Environmental permit granted and approved environmental management plan in place. At Kwale operation in 2023 no significant incident and 34 minor incidents (e.g. water leaks, vehicle oil spills).                                                                                                                                                                                                            |
| Efficient use of energy, renewable energy, GHG emissions reporting | Power requirements stage 1: 15 MW; Stage 2: 24 MW; for power supply a hybrid heavy fuel oil, photovoltaic, battery plant is planned, designed to maximise photovoltaic contribution; no detailed information actual renewable share available. Decarbonisation Study (not reviewed for this assessment) for the Toliara project is finished.                                                                   |
| Water management and consumption                                   | Semi-arid region with medium to high water stress. Base Resources stating suitable supply confirmed by groundwater modelling; groundwater abstraction permit for 899m <sup>3</sup> /h; supply needs for stage 1: 526 m <sup>3</sup> /h; stage 2: 972 m <sup>3</sup> /h. Riverine flood risk extremely high.                                                                                                    |
| Pollution prevention                                               | Depending on natural Th/U content, HMS concentrates and tailings may lead to considerable radioactivity; reports on opposition due to fear of high radioactivity (Mongabay (2019a)), no detailed information available on this topic. Mining and processing comprising mechanical excavation and gravitational, magnetic, and electrostatic separation; generally low pollution risks from applied technology. |
| Air quality                                                        | Potential of dust emission during feeding of the dry mining unit, initial screening, afterwards the ore is processed as slurry, and landscape remodeling until revegetation. Scarcely populated area risk is seen as generally low; if necessary basic dust suppression (e.g. sprinkling) should be adequate. Special requirements depending on radioactivity of monazite content; see "Pollution prevention". |
| Tailings management                                                | Out-of-pit tailings storage is required for the first 15 months of operation to create the mine void for in-pit disposal; see "Mine closure" for more information. Radioactivity of monazite content not clear at this stage; see "Pollution prevention".                                                                                                                                                      |
| Waste management                                                   | No specific information available at this stage.                                                                                                                                                                                                                                                                                                                                                               |
| Hazardous materials management                                     | No specific information available at this stage; planned mining and processing approach does not imply particular hazardous materials.                                                                                                                                                                                                                                                                         |
| Noise and vibration                                                | Emission from planned mining approach not particular high, and area scarcely populated; considered low risk.                                                                                                                                                                                                                                                                                                   |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Protected areas and biodiversity                          | Project site in the Madagascar Spiny Thicket ecoregion, which is classified as 'Critical Endangered'. The project is surrounded by the NAP PK32-Ranobe protected forest area. Base Resources states that conservation programs in course of the project may improve biodiversity; development of a Biodiversity Action Plan is anticipated. Indigenous Tree and Plant Nursery established in 2019, propagating 183 endemic species until 2023.                                                                                                                                                                                                                                                                                                               |
| Mine closure                                              | Progressive rehabilitation is planned filling the created mine void continuously with tailings, grading the landform, replacing the topsoil and re-vegetating the area; time from initial land clearing to finalised rehabilitation is expected to take 3 to 4 years. Evaporation ponds for fine tailings will be created on top of coarse tailings. A co-disposal approach of fine and coarse tailings, resulting in a better soil structure for re-vegetation, is tested at Kwale project in Kenya.                                                                                                                                                                                                                                                        |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Community health, safety and security                     | Area is sparsely populated; next settlement are the towns of Ankilimalinika and Ambolomailaka ~10 km west / south-west; regional capital of Toliara (~160,000 inhabitants; census 2013) ~50 km south of the project. No information on economic activities at the project area; reports of partly violent conflict existing (see "Dialogue and engagement with communities and stakeholders").                                                                                                                                                                                                                                                                                                                                                               |
| Dialogue and engagement with communities and stakeholders | Stakeholder consultation programs currently on hold due to Government on-ground suspension of activities; Base Resource states continuous support from local communities for lifting of the suspension. However, reports on conflict with communities, including the destruction of Base Resources exploration camp, dating back to 2019; reported conflict areas including environmental concerns, displacement and corruption. It is not clear from recent reporting whether these conflicts have been resolved or not (Mongabay (2019a); Mongabay (2019b)). The living space of the hunter-gatherer society of the Mikea people extends west of the project area as far as the city of Toliara; no information on possible impact on the Mikea available. |
| Land acquisition and involuntary resettlement             | Development of Resettlement Action Plan (aligned to IFC Performance Standard 5 – Involuntary Resettlement, Livelihood Replacement Plan, and Tomb Relocation Program) currently on hold due to on-ground suspension of activities. Base Resources reports the support of 20 households of employees at the exploration camp, who were expelled by an opposition group during the exploration camp destruction.                                                                                                                                                                                                                                                                                                                                                |
| Occupational health & safety management                   | No information on OHS management for the Toliara project at this stage. Comparison with the Kwale project in Kenya indicating good management practices by Base Resources: 0 lost time injuries; 0.21 total recordable injury frequency rate; ~4,750 million hours worked.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Workers' rights                                           | Madagascar scores 65/100 in the Labour Rights Index; no indication of any shortcomings on side of Base Resources found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

| ESG category                                | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gender and diversity                        | Base Resources is dedicated to increase the share of women in the workforce; Toliara project 39 % (hiring of operational workforce pending), companywide 18 %.                                                                                                                                                                                                                                                                                                         |
| Local value added and community development | Anticipated workforce for operation phase ~750 employee (60 – 50 expats); ~200 contractors. Skill development program started in 2019; 500 people selected for traineeship from 7,000 registrations. Community Development Management Plan to be developed focusing on health sector; education programs; community infrastructure; livelihood enhancement; financed by US\$ 10m before start of operation, US\$ 3m per year, and 70 % of royalties; royalty rate 4 %. |
| <b>Governance</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Legal compliance                            | Acquiring of mining license, construction approval, environmental baseline studies, and land acquisition process currently on hold due to on-ground activity suspension. Local officials accused of corruption in land acquisition, no evidence of active involvement of Base Ressources (Mongabay (2019a)).                                                                                                                                                           |
| Management practices                        | No evidence of practice at this project stage; management practice at Kwale project as a reference appears sufficient.                                                                                                                                                                                                                                                                                                                                                 |
| Transparency and reporting                  | Listed at ASX; reports on financial accounts and shareholder structure available. Adopted reporting standards: GRI Standards 2021; SASB Metals and Mining Standards; ICMM Mining Principles and Performance Expectations; ICMM Guidance on Social and Economic Reporting.                                                                                                                                                                                              |
| Business ethics                             | Madagascar scores 25/100 in the Corruption Perception Index; Madagascar is an EITI country; Base Resources is EITI supporter.                                                                                                                                                                                                                                                                                                                                          |

Table 62. ESG features of Toliara project, Madagascar

#### 4.27.4 Further reading

Base Resources Ltd. (2021a): DFS2 enhances scale and economics of the Toliara Project. <https://wcsecure.weblink.com.au/pdf/BSE/02426235.pdf> (accessed: 16.11.2023)

Base Resources Ltd. (2021b): Company presentation – Africa Down Under presentation. <https://wcsecure.weblink.com.au/pdf/BSE/02709261.pdf> (accessed: 16.11.2023)

Base Resources Ltd. (2023a): Sustainability Report 2023. <https://s3.ap-southeast-2.amazonaws.com/assets.baseresources.com.au/wp-content/uploads/2023/11/23132624/2023-Base-Resources-Sustainability-Report-FINAL.pdf> (accessed: 16.01.2024)

Base Resources Ltd. (2023b): Sustainability Data Book 2023. <https://s3.ap-southeast-2.amazonaws.com/assets.baseresources.com.au/wp-content/uploads/2023/11/23132624/2023-Base-Resources-Sustainability-Report-FINAL.pdf>

[content/uploads/2023/11/23132932/2023-Sustainability-Data-Book-Protected.xlsx](#) (accessed: 16.01.2024)

Mongabay (2019a): Madagascar mine ignites protests, community division.

<https://news.mongabay.com/2019/07/madagascar-mine-ignites-protests-community-division/> (accessed: 16.01.2024)

Mongabay (2019b): Madagascar suspends activities at controversial Base Toliara mine.

<https://news.mongabay.com/2019/11/madagascar-suspends-activities-at-controversial-base-toliara-mine/> (accessed: 16.01.2024)

## 4.28 Uis Sn-Li pegmatite project (Namibia)

Information as of 03/2023

### 4.28.1 General project background

|                                 |                                                                                                                                                                                                                           |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Tin (currently) / Lithium (potentially)                                                                                                                                                                                   |
| <b>Other commodities</b>        | Tantalum                                                                                                                                                                                                                  |
| <b>Location</b>                 | Erongo region, Namibia<br>21°14' S, 14°52' E, 800 – 900 m.a.s.l.                                                                                                                                                          |
| <b>License type</b>             | Mining license ML 134 (200 km <sup>2</sup> ), valid until 21.08.2028                                                                                                                                                      |
| <b>License owner / operator</b> | Andrada Mining Ltd. (formerly Afritin Mining Ltd.)<br>(public company)                                                                                                                                                    |
| <b>Contact</b>                  | Illovo Edge Office Park, Building 3, 2nd Floor<br>Illovo, South Africa<br><a href="https://www.andradamining.com">https://www.andradamining.com</a><br><a href="mailto:info@andradamining.com">info@andradamining.com</a> |
| <b>Project status</b>           | Production (phase 1), expansion planned (phase 2)                                                                                                                                                                         |
| <b>Production by 2030</b>       | Tin mine (phase 1) already in production; phase 1<br>lithium recovery likely, as pilot plant already operating                                                                                                            |



Figure 47. Uis project location, Namibia



### 4.28.2 Economic assessment

#### General project background:

The Uis tin mine was discovered in 1911 and mined at a larger scale from 1953-1990. It is a high-tonnage, low-grade tin deposit, but also contains a considerable amount of petalite, a lithium mineral. It is a pegmatite deposit. The thickness of mineralised pegmatite veins ranges from several meters up to more than 50 m. The veins are dipping at 35-40°, leading to an increase in the waste to ore ratio with depth. Mining is already taking place (phase 1 expansion from October 2022, 2 Mt per year), but has focused on only few pegmatites so far. The owner seeks investment to increase the production (phase 2, 10 Mt per year), including producing not only tin but also lithium (petalite) in concentrates. Tantalum is a possible by-product.

#### Project description:

|                                                 |                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                                | Pegmatite                                                                                                                                                                                                                                                                        |
| JORC compliant reserves, tin only               | 15.6 Mt @ 0.138 % Sn                                                                                                                                                                                                                                                             |
| Share of global tin reserves                    | 0.5 % ( <i>USGS estimate global Sn reserves of 4.6 Mt</i> )                                                                                                                                                                                                                      |
| JORC compliant resources                        | 81 Mt @ 0.15 % Sn, 0.73 % Li <sub>2</sub> O, 86 g/t Ta                                                                                                                                                                                                                           |
| Non JORC compliant resources                    | 215 Mt @ 0.139 % Sn, 0.59 % Li <sub>2</sub> O, 85 g/t Ta                                                                                                                                                                                                                         |
| Share of global tin resources                   | 1.6 % for 80.4 Mt / 4.0 % for 215 Mt<br>( <i>BGR estimate* global Sn resources of 7.5 Mt</i> )                                                                                                                                                                                   |
| Share of global lithium resources               | 0.6 % for 80.4 Mt / 1.3 % for 215 Mt<br>( <i>BGR estimate* global Li<sub>2</sub>O resources of 100 Mt</i> )                                                                                                                                                                      |
| Waste to ore ratio (whole orebody)              | 2.6 for 215 Mt                                                                                                                                                                                                                                                                   |
| Annual production                               | 2 Mt of ore (phase 1 expansion), 1,800 t Sn contained metal<br>Planned: 10 Mt of ore (phase 2), 9,000 t Sn contained metal,<br>18,000 t Li contained metal                                                                                                                       |
| Life of mine                                    | 20 years (post-expansion for the 215 Mt resource)                                                                                                                                                                                                                                |
| Investment required                             | US\$ 440m (for expanding to phase 2)                                                                                                                                                                                                                                             |
| Net present value (NPV)                         | US\$ 2.1bn (after tax, discount rate 8 %, based on tin price of<br>US\$ 40,500/t)                                                                                                                                                                                                |
| Share of global tin production<br>(phase 2)     | 2.9 % (10 Mt of ore per year, recovery 70 %)<br>( <i>USGS estimate global Sn production of 310,000 t</i> )                                                                                                                                                                       |
| Share of global lithium production<br>(phase 2) | 6.8 % (10 Mt per year, recovery 30 %)<br>( <i>USGS estimate global Li<sub>2</sub>O production of 280,000 t</i> )                                                                                                                                                                 |
| Value addition potential                        | Tin smelting will take place outside of Namibia. Petalite is<br>directly used in glass manufacturing, which could in part take<br>place in Namibia. Petalite use in lithium-ion battery supply<br>chains would require chemical processing not established in<br>Namibia so far. |

#### Mining and processing:

- Conventional open pit methods employing drilling, blasting, and hauling over multiple pegmatite orebodies in four to five pits. The phase 2 mining plan envisages an ore production

rate of 10 Mt/a with a relatively low average waste to ore ratio of 2.6 (for 215 Mt of resources). The waste to ore ratio will increase as mining progresses into the deeper parts of the ore body.

- The operating expenditures are given at US\$ 20.3/t of ore processed plus transport to the final customer/smelter. This is within an expectable range for a high-tonnage operation.
- Tin is concentrated via crushing (no milling required due to coarse grain size), spiral classification, shaking tables, and magnetic separation to produce final tin and tantalum concentrates. The concentrate grade is >60 % tin with very low grades of uranium and thorium, which minimizes potential transport and smelting issues with the concentrate. The tin recovery rate is 65-70 %, which is good for a density separation process.
- Petalite concentration tests are still at a pilot plant stage. It is planned to use the rejects from tin separation for different ways of dense media separation and/or flotation (depending on the grade) to yield a final concentrate of 4 % Li<sub>2</sub>O. The lithium recovery rate has not been finally demonstrated and is thus given at only 30 %, which BGR assumes to be conservative.

#### **BGR assessment and comments:**

- The deposit is a low-grade, high-tonnage operation with a relatively low waste to ore ratio of 2.6. The relatively long life of mine (20 years) can be positive for the development of the region. Resource expansions are possible due to the occurrence of many pegmatites in the vicinity, which have not yet been tested for tin and lithium (and tantalum).
- Andrada Mining assumes high tin prices of US\$ 30,000/t and in some studies US\$ 40,500/t for its economic assessment. In contrast, the average tin price for the last 5 years was only US\$ 25,000/t. A more conservative price of US\$ 20,000 to US\$ 25,000 is recommended.
- With tin as the only commodity, the low-grade mining project would face difficulties to profitably extract the complete resource when tin prices decline, especially in the deeper part of the ore body.
- In case petalite concentrate can be produced, lithium and tin would be co-products, with lithium being the most important commodity at a petalite concentrate price of US\$ 1,150/t and the economic feasibility and viability of a combined lithium-tin project would appear to be good. The prices for lithium concentrates, have increased more than ten-fold in the last two years, but also decreased sharply in 2023 to far below 1,150 US\$/t of petalite concentrate.
- Uis is connected to the next port in Walvis Bay (230 km) by gravel road in excellent condition and paved road. There is no railway available. Electrical power is available from the Nampower grid. The next small settlement, Uis, is around 2 km from the entrance to the mine. Water is supplied ~50% surface water and from groundwater each (phase 1) and, for phase 2, could be supplied by pipeline (around 120 km) from a desalination plant close to Henties Bay.

### 4.28.3 ESG assessment

The level of publicly available project information is good. No major ESG issues were identified that would preclude responsible investment. The operator comprehensively documents its corporate policies and management systems. Environmental risks are considered to be low, although water management in the arid environment may be challenging. Stakeholder engagement and OHS management is widely in place, as are CSR measures. The operator rates its own OHS performance in 2022 as unsatisfactory and is investigating improvement measures. Possibly contentious issues concern worker remuneration and illegal ASM on the site.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Environmental Management                                           | Comprehensive policies and reporting documented; ISO 14001 certification envisaged. Based on internal classification from Level 1 to 5 (Minimal - Extreme), 34 Level 1, 39 Level 2, and 2 Level 3 environmental incidents recorded in 2022; Level 3 incidents were below requirement of reporting to authorities; goal is no incidents higher Level 2.                                                                                                                                                                                                                       |
| Efficient use of energy, renewable energy, GHG emissions reporting | Electrical power from grid, diesel generators for backup. Working towards reducing Scope 1 and 2 as well as disclosing Scope 3 emissions. Energy demand of 58,733 GJ or 0.13 GJ/t processed ore; Scope 1: 2,513 t CO <sub>2</sub> -eq, Scope 2: 5,695 t CO <sub>2</sub> -eq, 0.018 t CO <sub>2</sub> -eq/t processed ore.                                                                                                                                                                                                                                                    |
| Water management and consumption                                   | Water supply is ~50 % surface water from a historic mine pit and from groundwater each; independent experts groundwater assessment (2021 - 2022) verifies sufficient water supply for phase 1; albeit groundwater level declined in recent years; use of desalinated seawater is under assessment. Arid region with low water use; prone to a high overall water risk (average rainfall is 35 mm/a). Demand about 140,000 m <sup>3</sup> /a, for phase 2: 1,350,000 m <sup>3</sup> /a; 85 % of water is recycled; withdrawal intensity 0.33 m <sup>3</sup> /t processed ore. |
| Pollution prevention                                               | Acid mine drainage potential assessment ongoing; low U/Th content considered no risk.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Air quality                                                        | Scarcely populated area, OHS management in place, considered low risk.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Tailings management                                                | Dry tailings disposal; tailings facility construction investigated for phase 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Waste management                                                   | In phase 1 co-disposal of waste rock and facility waste; waste hierarchy management approach in development; hazardous waste (in particular hydrocarbons) handled by accredited waste management company.                                                                                                                                                                                                                                                                                                                                                                    |
| Hazardous materials management                                     | Non-chemical beneficiation process, considered low risk.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Noise and vibration                                                | OHS management in place, scarcely populated area, considered low risk.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Protected areas and biodiversity                                   | The project is not located in or close to a key biodiversity area. The site is a historical mining area; expected biodiversity impacts are low.                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Mine closure                                                       | Provisions are made on a progressive basis. Liabilities have been calculated at around US\$ 237,000 for phase 1; development of mine closure plan is stated as short-term priority. No liability on old mine workings.                                                                                                                                                                                                                                                                                                                                                       |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                               |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                          |
| Community health, safety and security                     | Scarcely populated area, local town of Uis (500 inhabitants) plus around 3000 people in surrounding villages, potential negative impacts from the mine on local communities are considered low risk.                                                                                                                                                     |
| Dialogue and engagement with communities and stakeholders | Structured and continuous dialogue with local communities in place as well as CSR measures; member of Settlement Development Council. ASM taking place on concession, no reports on conflicts, evaluating potential integration measures with legislator stated as long-term priority.                                                                   |
| Land acquisition and involuntary resettlement             | It is a former mining site, there are / have been no settlements on the license area. Land use in the area is limited to herding, no agriculture use.                                                                                                                                                                                                    |
| Occupational health & safety management                   | Professional management and OHS measures on site, OHS policy in place, ISO 45001 certification envisaged. OHS Performance: 0 fatalities; 4 lost time injuries; 6.26 lost time injuries / million hours worked; 12.53 recordable injuries / million hours worked; did not meet the company's expectation, possible improvement measures are investigated. |
| Workers' rights                                           | Namibia scores 68.5/100 in the Labour Rights Index. Relevant policies in place. Around 128 employees plus 187 contract workers, for planned expansion several hundred additional workers may be expected. 69 % of workers are member of a labour union; dispute suggests potential conflict around wages (recorded 07/2022).                             |
| Gender and diversity                                      | Non-discrimination policy in place; share of women in the workforce: 75 % management, 30 % employees, 7 % contractors.                                                                                                                                                                                                                                   |
| Local value added and community development               | Local value contribution considered generally high. Local and national employees >97 %; training program aims to employ 30 % of workforce directly from Uis and Dâures constituencies, and 30 % from the Erongo region. N\$ 143m (49 %) of procurement from Namibia; total community investment N\$ 186,918 for CSR measures.                            |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                          |
| Legal compliance                                          | Relevant environmental license (environmental clearance certificate) obtained. No indication of any breaches of law found.                                                                                                                                                                                                                               |
| Management practices                                      | Comprehensive and structured information on ESG policies and management. ICMC benchmarking and IFC Performance Standards documentation; latest ESIA report 2019, review for an update ongoing; risk assessment in annual report; ISO 14001, ISO 45001 envisaged.                                                                                         |
| Transparency and reporting                                | Listed on the AIM market of the London Stock Exchange and on the Namibian Stock Exchange; extensive information for investors, reports on financial accounts and shareholder structure available; the Sustainability Report 2022 considers GRI and SASBS reporting requirements.                                                                         |
| Business ethics                                           | Namibia scores 49/100 in the corruption perception index; Namibia is not an EITI country; no indication of unethical practices found; financial accounts according to stock listing requirements; company with registered office in Guernsey.                                                                                                            |

Table 63. ESG features of Uis project, Namibia

#### 4.28.4 Infrastructure assessment

##### Potential Investment Needs:

- **Road Infrastructure:** With the anticipated phase 2 expansion, there might be a need for significant improvements in the existing road networks.
- **Railway Enhancements:** The railway station, particularly the bulk loading facilities, tracks, and rolling stock, might require upgrades to meet the demands of phase 2.
- **Renewable Energy Ventures:** Given the increasing emphasis on reducing CO<sub>2</sub> emissions, investments might be channelled into extension of renewable energy supply.
- **Water Supply:** With the ever-growing demands for water, Uis Infrastructure is exploring alternatives like desalinated seawater.
- **Port Storage Facilities:** As the phase 2 extension progresses, there could be an increased demand for port storage. Investing in expanding or enhancing port storage facilities will be crucial to accommodate the anticipated quantities.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | The location is categorised as undeveloped countryside. Currently, there are no restrictions concerning building heights. Telecommunication infrastructure is available at the site. Brandberg Medical Center and Uis clinic are the nearest medical healthcare facilities in town.                                                                                                                                                                                                                                   |
| Transport                 | Through the secondary routes C35 and C36, which are partly gravel and paved roads in excellent condition, the Uis site is connected to the port, airport, bigger neighbouring towns, and the paved highway B2. The Roads Authority, a state-owned enterprise established in 1999, operates and maintains the above public roads. Investments into the truck fleet, loading facilities, and road infrastructure might be necessary for the upcoming phase 2.                                                           |
| Airport                   | Uis is close to several airports. The main one being Uis Mine Regional Airport, merely 2 km away. There are also nine additional small airports within a 100 km radius. Both public and private entities share ownership. These airports are equipped to transport materials and individuals. Larger equipment can be brought in via the Karibib Airport upon request, which is the Namibian Air Force HQ since 2016. This connection seems adequate for operational and technical needs.                             |
| Rail access               | The nearest rail station is at Omaruru, 120 km away, operating on the Kranzberg-Otavi connection managed by TransNamib Holdings Limited. This single-line narrow gauge railway is public-owned. Investments in upgrading bulk loading facilities and other aspects of the railway may be considered for phase 2.                                                                                                                                                                                                      |
| Port                      | Walvis Bay, a secured and congestion free shallow seaport situated 230 km away from Uis, accessed via the C34 and C35 routes, can handle bulk, containerized, frozen and dry cargo. Current container capacity ranges from 400,000 TEUs to 750,000 TEUs annually. Managed jointly by the public-private partnership Walvis Bay Corridor Group and Namport, this port facilitates trade for regions like Namibia, Zambia, Democratic Republic of Congo, and Botswana. Contracts with China Harbour Engineering Company |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | Ltd. for extension are in place. Plans for its development intend to further bolster the existing trade corridors (road and rail) improving also the mining sector. With a depth ranging from 12.8 to 16 m, it is specialized in accommodating handy-size ships possessing a maximum length of 192 m and draft of 10 m with 15,000 to 35,000 dwt. A floating dry dock has been added that can lift vessels up to 150 m in length with a 25-m beam and displacing 8,500 t. The port features offload and onload facilities including electric rail-mounted wharf cranes, mechanical appliances, and rail track lifting capabilities. Storage facilities comprise two cargo sheds offer 7,900 m <sup>2</sup> , while raised ore platforms cover 5,708 m <sup>2</sup> . Additionally, two ore bins total over 11,000 m <sup>2</sup> , with one having a conveyor loader. A privately-operated cold storage provides 15,000 m <sup>3</sup> , and there's 30,000 m <sup>2</sup> available for 'rough' goods storage. The majority of goods arrive by truck (90 %), followed by train (10 %). |
| Energy       | The Nampower grid in Omaruru, Namibia, hosts a substation less than 1 km from the mine site, managed by Omburu Innosun Energy Holdings PTY LTD, and capable of handling up to 66 kV with a frequency of 50 Hz. It is connected via Omburu – Otjompaue – Uis line with the main substation in Omburu capable of handling up to 400 kV. There are three photovoltaic plants (2x Omburu, 1x Karibib) in the area, generating renewable energy. Additionally, Omburu features the first utility-scale Battery Energy Storage System in Namibia with a capacity of 58 MW / 60 MWh, ensuring both production and efficient storage of renewable energy.                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| GHG emission | To curb CO <sub>2</sub> emissions and reduce power grid dependencies, investments are directed towards renewable energy sources like solar farms. Projects such as the BESS and the Gildemeister solar park enhance this initiative. Estimated solar plant costs for 2021 are between US\$ 580 to 870 per kWp, expected to decrease in the future. The required investment is around US\$ 4m to 6.1 m for about 7,000 kWp excluding annual maintenance costs. Gildemeister's solar park, with a capacity of 6.5 MWp, will produce approximately 14 GWh (~50,400 GJ) of electricity annually                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Water        | The current phase requires 140,000 m <sup>3</sup> /a (available), while the planned phase 2 will need 1.35 million m <sup>3</sup> /a. Considering future water supply stability, the potential use of desalinated seawater is being evaluated. Here a second desalination plant is also under discussion in Namibia. For example, Erongo Desalination Plant costs around US\$ 153m for construction and provides 12 to 45 million m <sup>3</sup> /a. The energy input necessary/production costs are considered to be high, while solar farms could reduce desalination plant's carbon dioxide emissions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

Table 64. Infrastructure assessment of Uis project, Namibia

#### 4.28.5 Further reading

Afritin Mining (2022): Uis phase 2 expansion: Preliminary economic assessment (PEA) results.

<https://andradamining.com/company-documents/2022-04%20ATM%20RNS%20Uis%20Phase%20%20PEA%20website.pdf> (accessed 08.03.23)

Andrada Mining (2023a): Significant Lithium Resource Upgrade.

[https://polaris.brighterir.com/public/andrada\\_mining/news/rns/story/x4g8q3x](https://polaris.brighterir.com/public/andrada_mining/news/rns/story/x4g8q3x) (accessed 08.03.23)



Andrada Mining (2023b): Sustainability Report 2022. <https://andradamining.com/company-reports/Sustainability-Report-2022.pdf> (accessed 08.03.23)

CSA Global (2019): Mineral resource estimate – V1/V2 pegmatites: Uis tin project. [https://andradamining.com/wp-content/uploads/2022/03/ATM\\_Mineral-Resource-Estimate\\_V1V2-Pegmatites\\_Uis-Tin-Project.pdf](https://andradamining.com/wp-content/uploads/2022/03/ATM_Mineral-Resource-Estimate_V1V2-Pegmatites_Uis-Tin-Project.pdf) (accessed 08.03.23)

Environmental Compliance Consultancy (2019): Afritin – Uis tin mine: Operational environmental management plan. [http://the-eis.com/elibrary/sites/default/files/downloads/literature/1431\\_EMP\\_Mining%20licence%20129\\_133%20and%20134%20in%20the%20Erongo%20Region.pdf](http://the-eis.com/elibrary/sites/default/files/downloads/literature/1431_EMP_Mining%20licence%20129_133%20and%20134%20in%20the%20Erongo%20Region.pdf) (accessed 08.03.23)

Hartmann, A. (2022): Uis tin mine workers are threatening to go on strike. <https://www.erongo.com.na/labour-ero/uis-tin-mine-workers-are-threatening-to-go-on-strike2022-07-27> (accessed 08.03.23)

## 4.29 Waterberg PGE sulphide project (South Africa)

Information as of 12/2023

### 4.29.1 General project background

|                                 |                                                                                                                                                                                                                                                             |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodities</b>      | Palladium, platinum, gold, rhodium                                                                                                                                                                                                                          |
| <b>Other commodities</b>        | Copper, nickel, ruthenium, iridium                                                                                                                                                                                                                          |
| <b>Location</b>                 | Limpopo, South Africa;<br>23°22' S, 28°54' E, 1,100 m.a.s.l.                                                                                                                                                                                                |
| <b>License type</b>             | Mining Right with SLP: LP 30/5/1/2/2 /2/10161MR<br>Exploration and mining licenses (total of 992,44 km <sup>2</sup> )                                                                                                                                       |
| <b>License owner / operator</b> | Platinum Group Metals Ltd. (public company)                                                                                                                                                                                                                 |
| <b>Contact</b>                  | 1100 Melville Street Suite 838 Vancouver,<br>British Columbia V6E 4A6, Canada                                                                                                                                                                               |
| Direct contact established: Yes | <a href="https://www.platinumgroupmetals.net">https://www.platinumgroupmetals.net</a><br><a href="mailto:allam@platinumgroupmetals.net">allam@platinumgroupmetals.net</a><br><a href="mailto:info@platinumgroupmetals.net">info@platinumgroupmetals.net</a> |
| <b>Project status</b>           | Feasibility complete                                                                                                                                                                                                                                        |
| <b>Production by 2030</b>       | Possible                                                                                                                                                                                                                                                    |

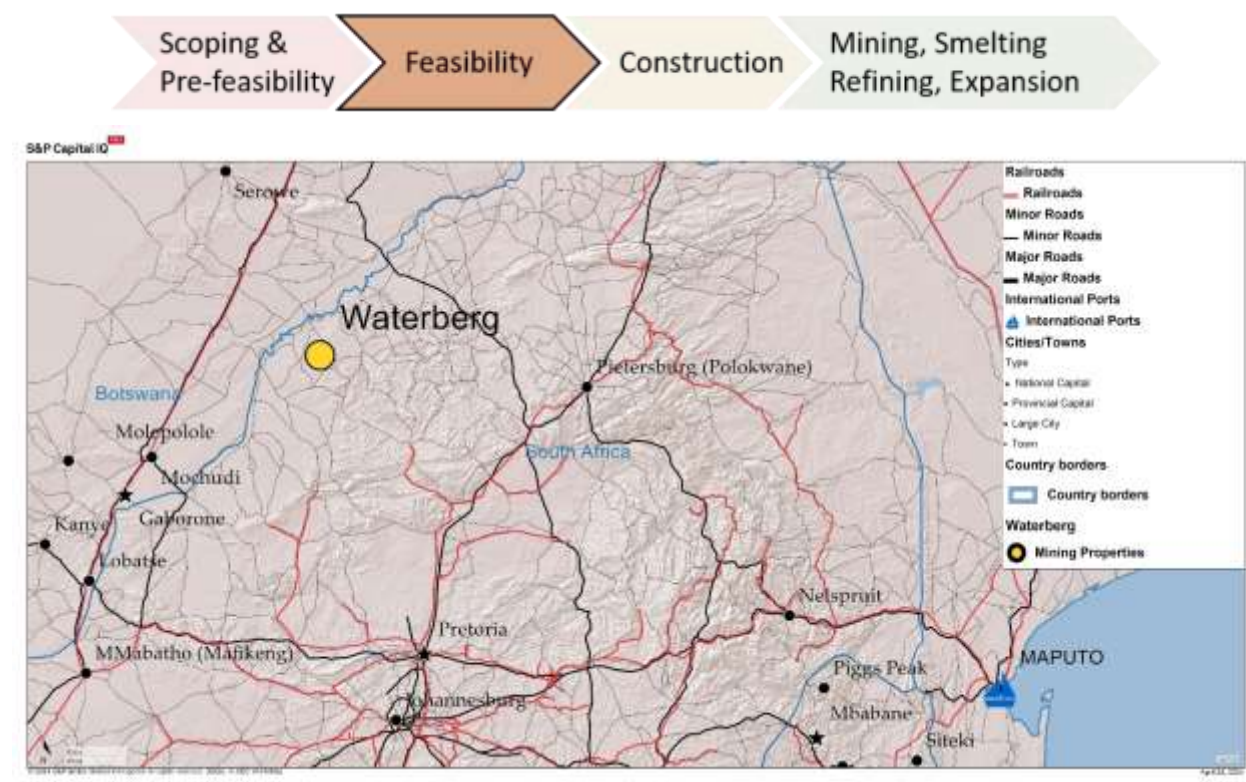


Figure 48. Waterberg project location, South Africa

## 4.29.2 Economic assessment

### General project background:

South Africa, in particular the Bushveld Complex, has an over 100-years PGE mining history. The Waterberg deposit is part of the far northern extension of the Northern Limb of the Bushveld Complex, with the Platreef as by far the largest PGE resource in the world. The mineralisation is hosted by disseminated sulphides as pentlandite, chalcopyrite, pyrrhotite and pyrite within mafic rocks as gabbro, norite, harzburgite, pyroxenite and anorthosite. The ore body is overlain by the Waterberg sediments with a thickness from 120 m up to 760 m within the project area. The ore formation is divided in two zones, the so-called T and F Zones. The T Zone is characterised by high Cu/Ni ratios and is Pd and Au dominated. Within the F Zone, PGEs are variable with dominant sperrylite and subordinate Pt-Pd bismuthotellurides, Au-Ag alloys, Pd arsenides, and Pt-Rh sulpharsenides. The ore zones strike northeast-southwest with a general dip of 34° to 38° towards the west. The definitive feasibility study was completed in late 2019. During Q4/2022, the company reported to advance the Waterberg to a development and construction decision including the arrangement of construction financing and concentrate offtake agreements.

### Project description:

|                                          |                                                                                                                                   |
|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                         | Sulphides and silicates within mafic host rocks                                                                                   |
| SAMREC compliant Proven mineral Reserves | 48.3 Mt @ 2.5 g/t 4E (Pd, Pt, Au and Rh)                                                                                          |
| Share of global PGE reserves             | 0.17 % ( <i>USGS estimate global PGE reserves of 70,000 t</i> )                                                                   |
| SAMREC compliant total resources         | 309.1 Mt @ 3.3 g/t PGE                                                                                                            |
| Share of global PGE resources            | no definitive information on world PGE resources                                                                                  |
| Annual production                        | 420,000 oz 4E in concentrate                                                                                                      |
| Life of mine                             | 45 years                                                                                                                          |
| Investment – total CAPEX                 | ZAR 13,105m (US\$ 874m) @ US\$ to ZAR of 1:15                                                                                     |
| Net present value (NPV) (post-tax)       | ZAR 5,616m-ZAR 12,388m (US\$ 374m-US\$ 826m), with a minimum royalty of 0.5 % and a maximum of 7 % (after tax, 8 % discount rate) |
| Share of global PGE production           | 2.8 % ( <i>BGR estimate global PGE production of 470 t in 2022</i> )                                                              |
| Value addition potential                 | The concentrates could be smelted and refined in South Africa                                                                     |

### Mining and processing:

- The Waterberg project will involve a mechanised underground mining operation accessed via declines from surface. Underground mining is planned with sublevel long hole stoping with backfill method. Diesel-powered underground mobile equipment is expected to be applied. However, significant advances in battery technology and the development of battery-powered mobile equipment are tested.
- Processing comprises crushing and screening, milling, classification and flotation. The mineral concentrates are filtered and dispatched afterwards, to obtain the final saleable

concentrate, containing between 30 and 108 g/t 4E (after metallurgical test work at MINTEC), plus up to 9 % copper, 5 % nickel and ~0.1 % cobalt. It is expected that the project will produce up 155,000 t/a of concentrate. Currently, Platinum Group Metals Inc. assesses the economic and political/regulatory feasibility of constructing a matte furnace and base metal refinery outside of South Africa (likely in Saudia Arabia) to process Waterberg concentrate.

- The calculated operating expenditures (OPEX) are US\$ 234m, resulting in a total project capital (CAPEX and OPEX) of US\$ 1,104bn. The economic calculations were based on three-year trailing prices for the raw materials to be produced: Pd: US\$/oz 1055; Pt: US\$/oz 931; Au: US\$/oz 1318; Rh: US\$/oz 1930; Ni: US\$/t 12248; Cu: US\$/t 6333. All price assumptions are reasonable.

#### **BGR assessment and comments:**

- Waterberg is a medium-grade, medium-tonnage PGE project. The relatively long life of mine (45 years) can provide opportunities for regional development. The ore formations are overlain by Waterberg sediments up to 760 m thick. This partially deep position and steep dip of the mineralised layers represents a certain challenge when building driving routes underground. Large amounts of PGEs are bound to silicate minerals. Processing test works resulted accordingly in lower product/concentrate quality, e.g. a lower PGE yield. A maximum 4E recovery of 84 % was obtained in producing a 118 g/t concentrate, which can definitely be considered as a sellable product. Additionally, 74 % copper and 45 % nickel were recovered as by-products.
- The Impala Platinum Holdings (IMPLATS) invested US\$ 30m in the project for a 15 % stake. They acquired a right of first refusal for future smelting and refining of concentrate. Hanwa Co. Ltd. holds the sole marketing right to purchase all metals from the project at market prices (acquired from JOGMEC). In 2023, Hanwa and JOGMEC established HJ Platinum Metals Ltd. to hold and finance their future interests in Waterberg. A contract has already been signed for the sale of concentrate to ramp up production at the mine.
- However, Platinum Group Metals Inc. is also advancing an initiative through Lion Battery Technologies Inc. using platinum and palladium in lithium battery technologies in collaboration with Anglo American Platinum Ltd and Florida International University.
- Access to the project from Mokopane is via a partly paved road for 85 km, access to the project for the last kilometres is via an unpaved road. Water and power supply are limited via drill holes and a 22 kV rural power distribution, respectively. Upgrading is planned for all existing infrastructure, including the upgrading of 34 km of the gravel roads to the N11 national road. Three PGE smelting hubs exist within South Africa in relation to the Waterberg mine site: Polokwane (109 km), Northam (312 km), and Rustenburg (417 km). Since the JV partner has a smelter complex at Rustenburg, it is anticipated that this will be the destination for the concentrate shipments.

### 4.29.3 ESG assessment

The level of data and information available is good to satisfactory, considering that the last comprehensive and reliable information about the project was compiled in 2020. The environmental risks are considered to be low. However, in general, the Limpopo Province is an area with high water stress in partly arid conditions. The agricultural activities, which are nevertheless sparse in the region, create a potential for conflict with regard to water use.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Environmental management                                           | The EMP for the Waterberg project is approved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Efficient use of energy, renewable energy, GHG emissions reporting | No information about emissions (scope 1 and scope 2) available. A 132kV electrical supply from the ESKOM Power Utility, that is mainly coal-based, is being built. No information about the use of renewable energies to date.                                                                                                                                                                                                                                                                                                                                                         |
| Water management and consumption                                   | Arid region with low water use. An integrated Water Use Licence as well as a Water Management License have been submitted. The estimated water demand for the Waterberg Project is calculated to be 6.2 MI/d. Groundwater draw down as well as alteration of hydrology are identified impacts from water production.                                                                                                                                                                                                                                                                   |
| Pollution prevention                                               | Pollution control dams are part of the plant infrastructure including stormwater berms and drains to divert rainwater from the plant water, which will be captured and not discharged to the environment.                                                                                                                                                                                                                                                                                                                                                                              |
| Air quality                                                        | Studies of air quality, heritage, noise and blasting are currently being carried out. However, no final results are available to date.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Tailings management                                                | TSFs with a capacity of at least 93 Mt are required and planned to be constructed as an upstream dam. Instances of catastrophic failure have been relatively more common at upstream-type dams, upstream facilities require rigorous TMS implementation to be operated safely. The dam was classified according to the South African National Standards as high hazard facility. The test work was undertaken by GCS Environment Engineering (Pty) Ltd. GCS classified the tailings as Waste Type 3. A certain portion of the tailings (Type 4 category) is prepared for backfill use. |
| Waste management                                                   | Waste rock storage facilities will be constructed. The waste stream generated from waste rock is classified as category 4 (see above). The waste rock dumps are also used for attenuation berms (see below) and an estimated 18 % will be disposed of in stopes as backfill material.                                                                                                                                                                                                                                                                                                  |
| Hazardous materials management                                     | Storage areas for hazardous waste materials such as batteries, lubricants, and other hazardous substances as medical waste will be provided. These materials will be disposed of by an accredited service provider.                                                                                                                                                                                                                                                                                                                                                                    |
| Noise and vibration                                                | Waste rock material will be used to construct an attenuation berm between the mining complex and the local Kgatu village community.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Protected areas and biodiversity                                   | The licence area is located about 20 km W of the Bellevue Natural Reserve. The distribution and extent of national biodiversity areas within the licence area falls within the grid 2328BD and show the relative ecological                                                                                                                                                                                                                                                                                                                                                            |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | sensitivity in the farms Millstream 358, Ketting 368 and Early Dawn 361. The total area has relatively low faunal sensitivities.                                                                                                                                                                                                                                                                                                                                     |
| Mine closure                                              | Waterberg Project is an underground mine, there rehabilitation is planned for vegetating or cladding the TSF only. Final rehabilitation will be completed within the context of the closure plan. Structures will be removed or repurposed for community use, mine access declines will be safely closed off. Closure cost for LOM are part of the financial estimations.                                                                                            |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Community health, safety and security                     | ESHIA programme in accordance with national law established. Public Participation Process is in progress. Social Labour Plan (SLP) is already approved.                                                                                                                                                                                                                                                                                                              |
| Dialogue and engagement with communities and stakeholders | Local landowners and communities were consulted and updated from the early prospecting stage; Platinum Group Metals Inc. states that stakeholder engagement is an ongoing process and a grievance mechanism will be developed to manage stakeholder concerns. No further information about the impact on the communities or possible conflicts with them available.                                                                                                  |
| Land acquisition and involuntary resettlement             | Land use agreements are already being concluded in the SLP with the local communities. No relocation of local villages needed and planned.                                                                                                                                                                                                                                                                                                                           |
| Occupational health & safety management                   | To date, there is no information available about planned occupational safety measures on site. However, the costs are determined at the headquarters/operational level and are included in the DFS.                                                                                                                                                                                                                                                                  |
| Workers' rights                                           | The SLP has already been approved (see above). According to the Labour Rights Index, South Africa currently scores 79/100.                                                                                                                                                                                                                                                                                                                                           |
| Gender and diversity                                      | No information available.                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Local value added and community development               | The local value proposition is considered to be high. Appropriate skills for mining, processing and engineering will be sourced from the local community. This also applies for administrative functions. Local development projects planned and approved include the provision of infrastructure and educational support to local schools. Royalties and production taxes are related to three-year trailing prices in the DFS and were specified as US\$ 54/oz 4E. |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Legal compliance                                          | Applications for a Water Use Licence as well as a Water Management License have been submitted or have already been approved by/to the competent authorities. Mining right and Environmental Authorisation submitted.                                                                                                                                                                                                                                                |
| Management practices                                      | DigBee ESG rating of "BB" (level 6 out of 10). Internal environmental, health, safety and technical policy established.                                                                                                                                                                                                                                                                                                                                              |
| Transparency and reporting                                | Listed at the Toronto Stock Exchange (TSX:PTM). Information for investors, reports on financial accounts and shareholder structure is available.                                                                                                                                                                                                                                                                                                                     |



| ESG category    | Assessment                                                                                                                                                                                                                              |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Business ethics | South Africa scores 41/100 in the corruption perception index; South Africa is not an EITI country. Code of business ethics, anti-bribery, human rights, whistle-blower policies available. No indication of unethical practices found. |

Table 65. ESG features of the Waterberg PGE project, South Africa

4.29.4 Further reading

Stantec – Mining (2019): Independent Technical Report: Waterberg project definitive feasibility study and mineral resource update, Bushveld Complex, South Africa.

[https://s27.q4cdn.com/928713426/files/doc\\_downloads/2022/02/Waterberg-DFS-Full-Final-Report-October-4-2019.pdf](https://s27.q4cdn.com/928713426/files/doc_downloads/2022/02/Waterberg-DFS-Full-Final-Report-October-4-2019.pdf) (accessed 15.12.2024)

## 4.30 Zulu Li (-Ta) pegmatite project (Zimbabwe)

Information as of 12/2023

### 4.30.1 General project background

|                                 |                                                                                                                                                                                                                                                                              |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Lithium                                                                                                                                                                                                                                                                      |
| <b>Other commodities</b>        | Tantalum                                                                                                                                                                                                                                                                     |
| <b>Location</b>                 | Matabeleland South, Zimbabwe<br>20°2' S, 29°24' E, 1,000 – 1,400 m.a.s.l.                                                                                                                                                                                                    |
| <b>License type</b>             | Zulu property: 14 Special Base Mineral claims (3.5 km <sup>2</sup> ),<br>Exclusive Prospecting Order EPO 1779 (205 km <sup>2</sup> )                                                                                                                                         |
| <b>License owner / operator</b> | Premier African Minerals Ltd. (public company)                                                                                                                                                                                                                               |
| <b>Contact</b>                  | Craigmuir Chambers, Road Town, PO Box 71,<br>Tortola, VG 1110, British Virgin Islands<br><a href="https://www.premierafricanminerals.com">https://www.premierafricanminerals.com</a><br><a href="mailto:info@premierafricanminerals.com">info@premierafricanminerals.com</a> |
| <b>Project status</b>           | Definitive feasibility underway, pre-production                                                                                                                                                                                                                              |
| <b>Production by 2030</b>       | Yes; currently commissioning and optimisation of pilot processing plant                                                                                                                                                                                                      |

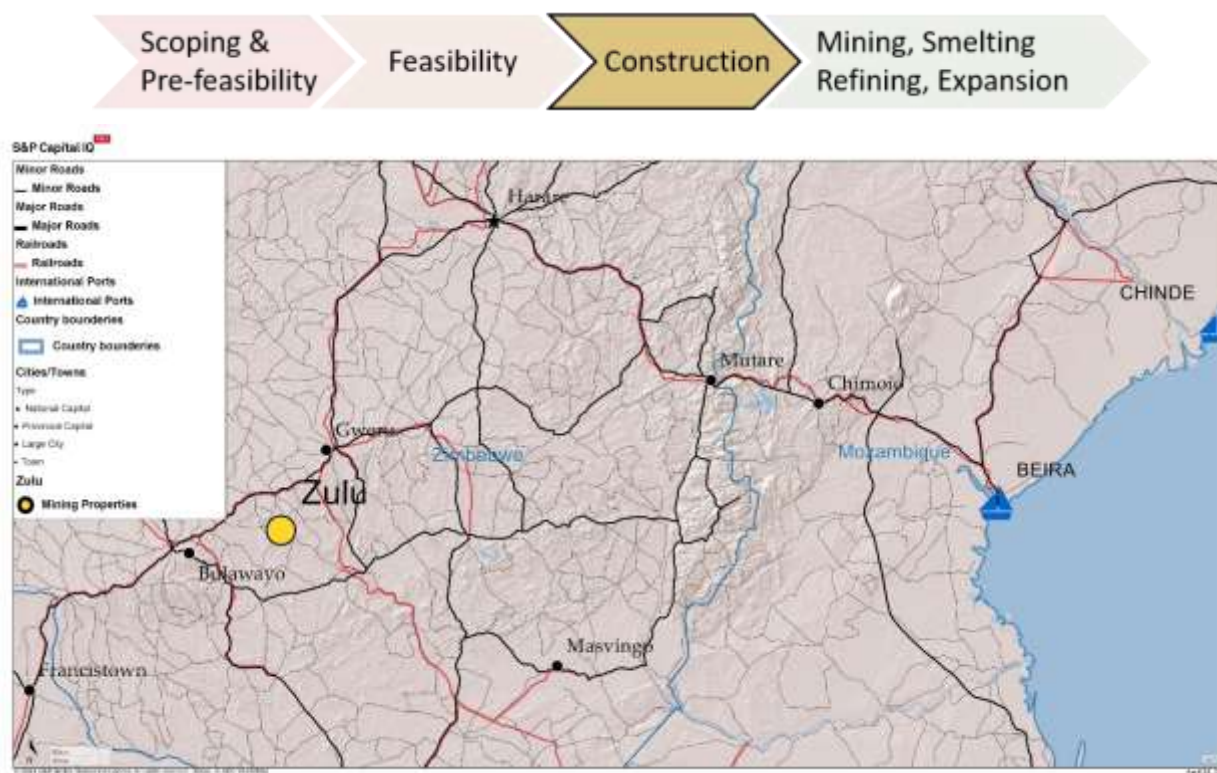


Figure 49. Zulu project location, Zimbabwe

### 4.30.2 Economic assessment

#### General project background:

The Zulu Project was first explored in 1955 and predominantly mined for gold, however, minor petalite production was reported for 1961 and 1962. The current owner, Premier African Minerals, acquired the project in 2010. The Zulu lithium-caesium-tantalum pegmatite swarm is located in the Archean Fort Rixon Greenstone Belt. The pegmatite swarm has intruded along the contact of serpentinite and metavolcanic/metasedimentary rocks over a strike length of several kilometres, controlled by a north-north-west trending fault. The pegmatites dip 70-90° to the west. The width varies between 10 and 25 m. Three pegmatite-types are identified, namely a spodumene-lepidolite-tantalite rich type, a petalite-lepidolite-tantalite rich type and a low lithium-lepidolite-high tantalite type. Currently, Premier ramps up spodumene concentrate (6 wt. %  $\text{Li}_2\text{O}$ ; SC6) production of a 48,000 t/a-capacity SC6 processing pilot plant with an envisaged processing life of 3 years. The owner seeks investment for the completion of a definitive feasibility study and for the post-pilot plant project stage.

#### Project description:

|                                       |                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                      | Pegmatite                                                                                                                                                                                                                                                                                                                                                                                                             |
| SAMREC compliant resources            | 20.1 Mt @ 1.06 % $\text{Li}_2\text{O}$ , 51 g/t Ta                                                                                                                                                                                                                                                                                                                                                                    |
| Share of global lithium resources     | 0.1 % ( <i>USGS estimate global <math>\text{Li}_2\text{O}</math> resources of 211 Mt</i> )                                                                                                                                                                                                                                                                                                                            |
| Waste to ore ratio (whole orebody)    | Not yet available                                                                                                                                                                                                                                                                                                                                                                                                     |
| Annual production                     | Pilot plant: 50 kt of spodumene, 3000 t of contained $\text{Li}_2\text{O}$<br>( <i>BGR assumes 375 kt plant throughput after sorting</i> );<br>Planned: 84 kt of spodumene (6 % $\text{Li}_2\text{O}$ ) and 32.5 kt of petalite concentrate, 6350 t of contained $\text{Li}_2\text{O}$<br>( <i>BGR assumes 630 kt plant throughput after sorting and a petalite grade of 3.5 % <math>\text{Li}_2\text{O}</math></i> ) |
| Life of mine                          | 15 years                                                                                                                                                                                                                                                                                                                                                                                                              |
| Investment required                   | US\$ 69.3m (refers to the total CAPEX for mine construction)                                                                                                                                                                                                                                                                                                                                                          |
| Net present value (NPV)<br>(Post-tax) | US\$ 279m (based on SC6 and petalite concentrate prices of US\$ 1,300/t and US\$ 400/t, respectively, and 10 % discount rate)                                                                                                                                                                                                                                                                                         |
| Share of global lithium production    | 2.3 % ( <i>USGS estimate global <math>\text{Li}_2\text{O}</math> production of 280,000 t</i> )<br><i>There is now further processing capacity for lithium minerals installed in Zimbabwe or neighbouring countries now. The mineral concentrate could be used in the glass manufacturing.</i>                                                                                                                         |
| Value addition potential              |                                                                                                                                                                                                                                                                                                                                                                                                                       |

#### Mining and processing:

- Conventional open pit methods employing drilling, blasting, and hauling over several pegmatite bodies. So far, the company did not address spodumene or petalite recoveries from mining and processing.

- Premier plans to process the ore into SC6 using a process flowsheet consisting of crushing, sorting, milling, screening, magnetic separation, mica flotation (possible lepidolite product), spodumene flotation, filtration and bagging. Testwork on petalite processing has not yet begun.
- The operating expenditures are given at US\$ 525.60/t of SC6 produced, which compares to an assumed SC6 price of US\$ 1,300/t. Lithium prices have been highly volatile in the last years.

#### **BGR assessment and comments:**

- The deposit is a medium-grade, medium-tonnage lithium operation. Resource expansions are possible related to further drilling campaigns along the 205 km<sup>2</sup> exploration permit area.
- Premier assumes a reasonable SC6 price of US\$ 1,300/t. The lithium price has been highly volatile since 2017 and reached a peak of over US\$ 8,000/t of spodumene concentrate (5-6 % Li<sub>2</sub>O) at the end of 2022. The lithium price as of December 2023 is ~US\$ 1100/t.
- The Chinese company Canmax (Suzhou TA&A Ultra Clean Technology) received a 13.38 % stake as part of a US\$ 14.37m private placement. Canmax also provided US\$ 35m in financing for a 48 kt/a capacity SC6 high-performance pilot plant and secured the entire offtake of this plant for 3 years. However, Premier has the option to cancel the contract at any time by financially settling the remaining debt not covered by the SC6 delivery. As the SC6 pilot plant is only designed for a life of 3 years and not for processing petalite, there is already a need for investment in the post-pilot plant project phase. The company is planning to expand SC6 production to 84 kt/a and additional petalite production of 32.5 kt/a.
- In the current project phase, lithium in the resources is connected to spodumene (70 %), petalite (25 %) and lepidolite (5 %). Premier evaluated the spodumene concentrate production as simple, whereas petalite is more complex and requires further testwork. Lepidolite and tantalum processing is currently not considered by the company. Pegmatites can be very heterogeneous and potential mineral enrichments are difficult to predict. It is therefore of the utmost importance that a feasibility study (i.e., infill drilling, metallurgical testworks) is carried out to provide a final assessment of the economic viability of the project. This study should also take into account the potential contribution of tantalum concentrates or other pegmatite-related commodities, e.g., feldspar, as by-products to the project economics.
- The Zulu project is located ~80 km east of, and connected to, Bulawayo via the paved A5 highway, accessed within ~30 km of gravel road. The following information originates from 2017 and may be outdated by now: The gravel road connecting to the A5 requires upgrades. Concentrate transport was planned via trucks to Bulawayo and then via rail to the port of Durban. Water was planned to be pipelined from the Upper Insiza Reservoir. Power was planned to be sourced from the national grid provided by the Zimbabwe Electricity Transmission & Distribution Company (ZETDC), which would have required the construction of a 25 km overhead line.

### 4.30.3 ESG assessment

No severe ESG issue identified that would pose a major risk anticipating diligent management and operational practice. However, the information level from publicly available reports is low, especially considering the anticipated short-term start of production. Therefore, an evidence of good practice is not given, which leads to a high uncertainty of the assessment. Furthermore, compilation of an ESIA and feasibility study is still ongoing, and granting of a dedicated mining licence appears to be pending also.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Environmental management                                           | No specific information on environmental management available; no reports on any incidents found.                                                                                                                                                                                                                                                                                                                                                                                                   |
| Efficient use of energy, renewable energy, GHG emissions reporting | The scoping study calculated power consumption at ~4 MW; the Zimbabwe electricity grid is dominated by coal power, hydro power has ~20 % share, current power production does not meet the demand; development potential for renewables is stated as high, especially for hydro and solar power.                                                                                                                                                                                                    |
| Water management and consumption                                   | Semi-arid region with low water stress; dry season is from April to October, rainy season from November to March; average precipitation 500 mm/a; high riverine flood risk. Hydrological assessment to be done. The scoping study estimated a water demand of 1.5 m <sup>3</sup> per t ore (~200 <sup>3</sup> /h); water supply is recommended from Upper Insiza Reservoir via pipeline (~24 km), no information on recycling rate available. Stream diversions north of the project area required. |
| Pollution prevention                                               | Flotation and leaching require potentially hazardous processing chemicals; the scoping study is stating hydrofluoric acid as part of the petalite flotation and that water from petalite flotation will not be re-usable; no further information on water treatment available.                                                                                                                                                                                                                      |
| Air quality                                                        | Proximity to rural communities requiring mitigation measures for dust emissions; assumed to be standard for state of the art mining operations.                                                                                                                                                                                                                                                                                                                                                     |
| Tailings management                                                | A TSF for 865,000 t/a over a 15 year lifetime and a resulting footprint of ~68 hectares constructed as ring dyke. The return water dam was calculated for a 1 in a 100-year stormwater event.                                                                                                                                                                                                                                                                                                       |
| Waste management                                                   | No specific information on waste management available.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Hazardous materials management                                     | No specific information on hazardous materials management available.                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Noise and vibration                                                | Proximity to rural communities requiring mitigation measures for noise emissions; assumed to be standard for state-of-art mining operations.                                                                                                                                                                                                                                                                                                                                                        |
| Protected areas and biodiversity                                   | Not in or close to any key biodiversity or designated protected area. Surrounding flatland area described as environmentally disturbed by subsistence farming including uncontrolled bush clearing; ridges relatively undisturbed providing retreat area for local flora and fauna.                                                                                                                                                                                                                 |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                             |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mine closure                                              | No detailed information available; scoping study recommends rehabilitation with special care blending in the ridge topography to support biodiversity (see “Protected areas and biodiversity”).                                                                                        |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                        |
| Community health, safety and security                     | Rural settlement area; current land use is primarily subsistence farming of cattle and maize. Exact number of affected population not clear, assumed to be several hundred; anticipating diligent management and operational practice, risk for local population is assumed to be low. |
| Dialogue and engagement with communities and stakeholders | No specific information on stakeholder engagement available.                                                                                                                                                                                                                           |
| Land acquisition and involuntary resettlement             | Necessary resettlement of ~6 households estimated in scoping study; no information on any ongoing or completed resettlement actions.                                                                                                                                                   |
| Occupational health & safety management                   | No specific information on OHS management available.                                                                                                                                                                                                                                   |
| Workers' rights                                           | Zimbabwe scores 71.5/100 in the Labours Rights Index; no indication of any shortcomings on site of Premier found.                                                                                                                                                                      |
| Gender and diversity                                      | No specific information on gender and diversity available.                                                                                                                                                                                                                             |
| Local value added and community development               | Provision of qualified work as development opportunity of the rural area dominated by subsistence farming; overall ~450 employee and contractors estimated in the scoping study.                                                                                                       |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                        |
| Legal compliance                                          | Compilation of ESIA and DFS pending; no information on mining permit available.                                                                                                                                                                                                        |
| Management practices                                      | No specific information on management practice available.                                                                                                                                                                                                                              |
| Transparency and reporting                                | AIM listed company; reports on financials and shareholder structure available. Lacking of ESG reporting posing an uncertainty in the assessment of good practice.                                                                                                                      |
| Business ethics                                           | Zimbabwe scores 24/100 in the Corruption Perception Index; Zimbabwe is not an EITI country; Zimbabwe is on the EU list of Conflict-Affected and High-Risk Areas (CAHRA). Anti-corruption and bribery policy in place; no indication of unethical practices by Premier found.           |

Table 66. ESG features of Zulu project, Zimbabwe

#### 4.30.4 Further reading

Bara Consulting Pty. Ltd. (2017): Zulu lithium project. Scoping Study.

<file:///C:/Users/Stoltnow.M/Downloads/2017%20Zulu%20Lithium%20Project%20Scoping%20Study%20-%20Bara%20Consulting.pdf> (accessed: 15.12.2023)



Bara Consulting Pty. Ltd. (2021): Updated Scoping Study for Zulu.  
<https://markets.ft.com/data/announce/full?dockey=1323-15098971-31KLJ4R61E1DN5V3ELSIC96G3M> (accessed: 15.12.2023)

Mining Technology (2023): Premier amends offtake deal with Canmax for Zimbabwe lithium mine. <https://www.mining-technology.com/news/premier-offtake-canmax-lithium-mine/?cf-view> (accessed: 23.01.2024)

Premier African Minerals Ltd. (2023a): Company presentation.  
[https://www.premierafricanminerals.com/investors/corporate-presentation/download-file?path=12+January+2023+UK+final\\_BR.pdf](https://www.premierafricanminerals.com/investors/corporate-presentation/download-file?path=12+January+2023+UK+final_BR.pdf) (accessed: 15.12.2023)

Premier African Minerals Ltd. (2023b): Premier African Minerals plans lithium shipments to China by March 2023. <https://www.mining.com/web/premier-african-minerals-plans-lithium-shipments-to-china-by-march-2023/> (accessed: 15.12.2023)

SADC Mining & Constuction (2022): Zimbabwe: Zulu Lithium Project Pilot Plant.  
<https://miningconstruction-sadc.com/zimbabwe-zulu-lithium-project-pilot-plant/> (accessed: 23.01.2024)

## 5 Refining and further value addition projects

For the purpose of the present report, ‘refining’ is understood as a summary term that includes crude refiners and smelters as well. Refining operations may be independent stand-alone facilities, often in third countries with a favorable market position and/or good infrastructure, or they may be connected to specific mines directly in the producer country. Several mines include on-site refining capacities, for instance to produce copper cathodes or crude cobalt hydroxide, especially in case they have acid leachable minerals. Some mines may also have associated refining facilities connected via pipelines over longer distances, but still situated in the same host country. In case of such vertically integrated operations, these combined mining and refining projects are shown in the present chapter, rather than in chapter 4 (‘mining projects’) of this report.

Refining is often associated with lower financial risks than mining, as long as supply agreements have been concluded to ensure sufficient use of plant capacities. In case of an integrated mining and refining project, the risk is comparable to a normal mining operation though. Risks are elevated whenever new processing and refining technologies are introduced that have not yet been frequently applied at a commercial scale. Introducing such new technologies often leads to significantly higher capital expenditure than originally anticipated. The operational margin in refining is usually lower than in mining.

There is a strong political drive among African governments to encourage or legally require increasing in-country value addition through refining and further value addition. As such, investing in refining projects may be seen as a welcome development. Care must be taken, though, to ensure the availability of sufficient local supply (not tied to offtake agreements with third parties) and a long term supply of raw materials / concentrates must be assured, as refining projects are usually longer-term investments. Additionally, expertise on processing technology (some of which may be proprietary or developed for very specific ore compositions), and adequate infrastructure (e.g., electricity, chemicals supply) must be available for refining operations. The ESG impact of refining operations may pose new challenges for local monitoring authorities since these impacts may be different from those generated in mining.

Value addition beyond refining requires careful consideration of the product’s market environment, since such operations are often deliberately placed close to downstream markets. Successfully expanding Africa’s share in value addition in the mineral value chain, therefore, is closely linked to the question of downstream market development and increasing demand trends in Africa itself.

## 5.1 Ambatovy Ni (-Co) laterite project (Madagascar)

Information as of 09/2023

### 5.1.1 General project background

|                                 |                                                                                                                                                                                                                       |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Nickel                                                                                                                                                                                                                |
| <b>Other commodities</b>        | Cobalt, ammoniumsulfate (fertiliser)                                                                                                                                                                                  |
| <b>Location</b>                 | Mine site: 18°51' S and 48°18' E, 1,000 – 1,100 m.a.s.l.<br>Refinery: 18°8' S and 49°24' E, 10 – 50 m.a.s.l.                                                                                                          |
| <b>License type</b>             | Exploitation Permit 459 (valid until 9.6.2046)                                                                                                                                                                        |
| <b>License owner / operator</b> | Ambatovy Minerals S.A; JV of Sumitomo Corporation (54.17 %; operator) and Korea Mine Rehabilitation and Mineral Resources Corporation (45.82 %)                                                                       |
| <b>Contact</b>                  | Immeuble Tranofitaratra; Rue Ravoninahitriniarivo                                                                                                                                                                     |
| Direct contact established: No  | Ankorondrano, Antananarivo 101; Madagascar<br>Phone: +261 32 33 665 65, Fax: +261 20 22 540 30<br><a href="https://ambatovy.com">https://ambatovy.com</a><br><a href="mailto:sales@ambatovy.mg">sales@ambatovy.mg</a> |
| <b>Project status</b>           | Mining and Refining                                                                                                                                                                                                   |
| <b>Production by 2030</b>       | Already in production                                                                                                                                                                                                 |

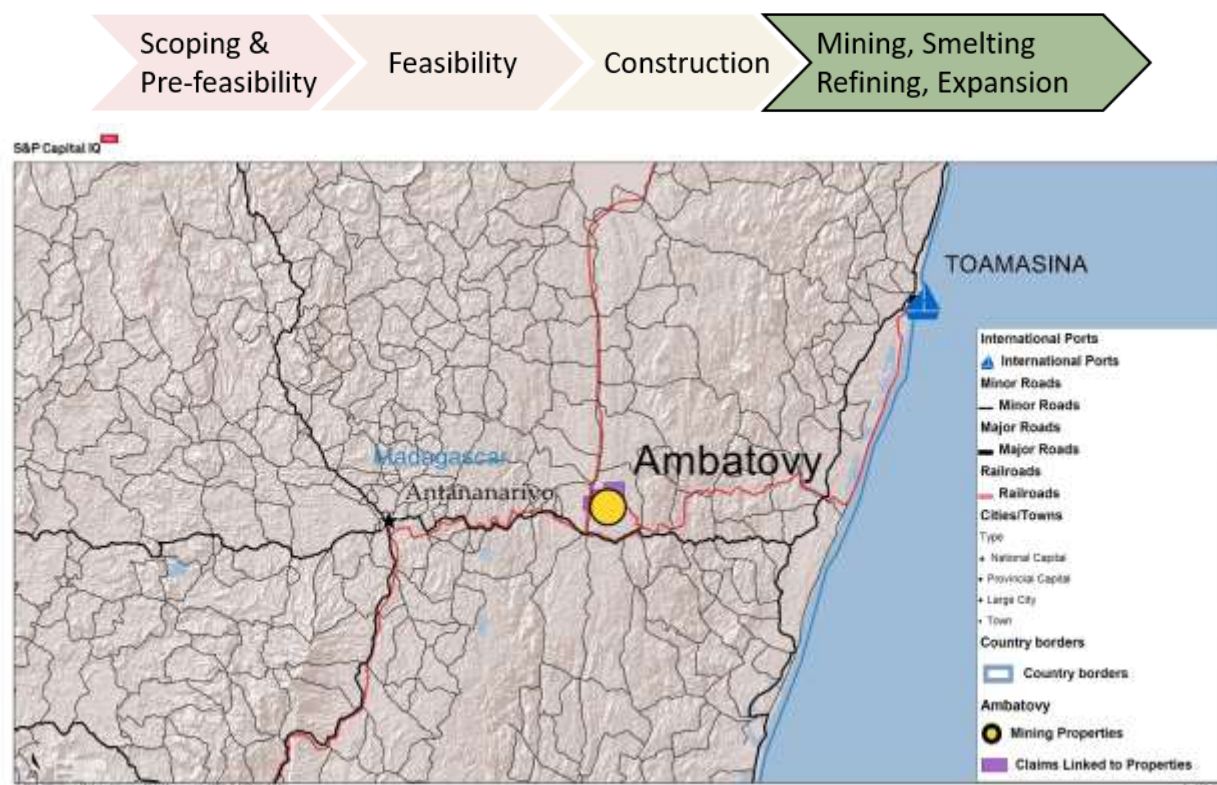


Figure 50. Ambatovy project location, Madagascar

### 5.1.2 Economic assessment

#### General project background:

The Ambatovy nickel-cobalt project located in Madagascar is one of the biggest lateritic nickel mining operations in the world. Involving a total estimated project cost of more than US\$ 8bn, the large-scale open-pit project also represents one of the biggest foreign investments in sub-Saharan Africa. The project is located in the Alaotra Mangoro region near the city of Moramanga, approximately 80 km east of the capital city of Antananarivo. The project hosts the Ambatovy and the Analamay lateritic nickel deposits located ~3 km apart. The inland mining license covers approximately 1,600 ha while refining takes place closer to the coastal port facilities, with ore slurry pumped through a 220 km distance pipeline. The mineralised laterite layer has an average thickness of approximately 50 m. The project design has an annual production capacity of 60,000 t of refined nickel, 5,600 t of refined cobalt, and 210,000 t of ammonium sulphate fertiliser over a mine life of minimum 26 years. All major investments and capital expenditures were realised in the 2007-2013 period. European funding, including a loan by the European Investment Bank, contributed to initial project development, along with other international funding partners. In the past, about 20 % of Ambatovy's nickel and cobalt production was directed to Europe.

#### Project description:

|                                    |                                                                                                                  |
|------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Ni(-Co)-laterite                                                                                                 |
| NI 43-101 compliant reserves       | 124.5 Mt @ 0.88 % Ni, and 0.08 % Co                                                                              |
| NI 43-101 compliant resources      | 130.1 Mt @ 0.91 % Ni, and 0.08 % Co                                                                              |
| Share of global nickel reserves    | 1.1 % ( <i>USGS estimate global Ni reserves of 100 Mt</i> )                                                      |
| Waste to ore ratio (whole orebody) | 1.0-1.1                                                                                                          |
| Annual production                  | 40,800 t of contained Ni and 3,200 t of contained Co                                                             |
| Life of mine                       | 40 years                                                                                                         |
| Investment required                | An estimated Capex of US\$ 8bn was used during construction.                                                     |
| Net present value (NPV, post-tax)  | US\$ 3.2bn (14 % discount rate)                                                                                  |
| Share of global nickel production  | 1.2 % (40,800 t Ni in 2022); ( <i>USGS estimate global Ni production of 3.3 Mt in 2022</i> )                     |
| Share of global cobalt production  | 1.7 % (3,200 t Co in 2022)<br>( <i>USGS estimate global Co production of 190,000 t in 2022</i> )                 |
| Value addition potential           | Refining takes place in Madagascar at the Ambatovy refinery in Toamasina that provides for vertical integration. |

#### Mining and processing:

- Conventional open pit mining methods employing hydraulic back-hoe or front shovels and haulage trucks. Blasting is not required due to the weathered ore bodies. Ore production rate is ~6 Mt/a.

- Mined ore is transferred to on-site ore preparation plant to separate laterite from waste. An ore slurry is produced and fed through a pipeline system to the processing plant (220 km away, close to the Port of Toamasina). There, the ore slurry is mixed with sulphuric acid and fed into autoclaves for pressure acid leaching at over 200 C. Leach discharge slurry passes through a counter-current decantation wash circuit to separate nickel and cobalt solution from the slurry. Tailings from the counter-current decantation wash circuit are neutralised and deposited. Nickel and cobalt are recovered from leach solution via precipitation process by high temperature and pressured hydrogen sulphide gas to produce mixed sulphides with high grades of cobalt and nickel. The precipitate undergoes leaching, filtration, sedimentation, and extraction with organic solvents to produce two separate, purified solutions of nickel and cobalt. The final products are washed, dried, and packed for export through the Port of Toamasina.
- Cash costs of about US\$ 8.75/kg Ni put Ambatovy project in lower half of cash cost curve of nickel. Supposing an average annual nickel price of above US\$ 20,000/t of nickel, the project could generate profits, though has struggled to turn a profit in past years, e.g., due to production bottlenecks (see below). At prices below US\$ 17,000/t Ni the pre-tax cash flow would be negative due to the high project CAPEX and relatively low nickel grade (about 0.9 % Ni-eq.).

#### **BGR assessment and comments:**

- The Ambatovy deposit is a typical low-grade, high-tonnage open pit operation. Because of the sheet-like, shallow laterite deposit geometry, a simple mining method is applied; the waste to ore ratio is low and stable over the life of mine, so that mining and processing costs through time are not affected by this parameter. The relatively long life of mine (until 2046) is positive for the development of the region. Mineral resource expansion is possible due to potential vertical extension of the deposit. Since start of production (2014) until now, the project has only achieved about 75 % of its design capacities. Production bottlenecks led to lower than expected plant throughput. Profitability of the project would increase significantly with increased capacity.
- Even though the project is situated in the lower half of the cash cost curve, the low nickel equivalent grade and the sustaining capital costs of about US\$ 80m/a imply that the project is only profitable at nickel prices above US\$ 20,000/t. Ambatovy's carbon footprint of about 44 t CO<sub>2</sub>/t Ni-eq. is average for nickel projects, but the CO<sub>2</sub>-intensity is quite high compared to other pressure acid leaching projects. This is due to its relatively low ore grades, the energy-consuming pipeline transport of the ore slurry to the refinery and coal-based energy supply. This could have a negative impact on project economics, if the CO<sub>2</sub>-emissions are monetarized in the future. Full design capacity would reduce CO<sub>2</sub> intensity of Ambatovy. Exploring this and other opportunities for reducing Ambatovy's CO<sub>2</sub> footprint, could make the project more attractive for battery and electric vehicle supply chains, where such emissions are a considered critical factor.

### 5.1.3 ESG assessment

Environmental and social performance of Ambatovy is regulated through a series of officially approved Environmental Management Plans and subject to regular inspections coordinated by the Ministry of the Environment (Office National de l'Environnement, ONE) with representatives from relevant government ministries. The company prepares an annual report that includes the results of all relevant monitoring programs. Major environmental issues could be caused by the clearance of primary forest at the mine site and the wet deposition of tailings at the processing plant that is not considered as best technology for nickel leaching. The use of coal as primary energy source at the plant causes a relative elevated CO<sub>2</sub>-intensity of the produced nickel. Ambatovy Minerals (AM) states that it adheres to stringent environmental standards including the Equator Principles, the World Bank Group's IFC Performance Standards, and the principles of the Business and Biodiversity Offsets Program (BBOP). As one of the initial lenders, the European Investment Bank independently verified complaints brought against Ambatovy by local residents.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Environmental Management                                           | Environmental permit No. 47/06/MINENVEF/ONE/DG/PE was issued on 1 December 2006. The ESMP makes provision for the development of specific management plans relating to the project. AM agreed to work with the Malagasy government and to establish a US\$ 50m environmental surety which could be accessed to correct any material breach of the applicable environmental laws, regulations and permits governing its environmental obligations.                                                                                                                                                                                                                                                                                                                                        |
| Efficient use of energy, renewable energy, GHG emissions reporting | The five major sources of GHGs used for monitoring are: diesel, coal, naphtha, liquid petroleum gas (LPG) and limestone. In 2022, Ambatovy Mineral's overall GHG emissions for the mine, plant and port facilities were estimated at a combined total of 1,931 kt of CO <sub>2</sub> -eq, resulting in a carbon intensity of 44 t CO <sub>2</sub> /t Ni-eq. production. At the plant site, coal, used for electrical power and steam generation was the primary source of GHGs. At the mine site, the main source of GHG emissions was diesel fuel.                                                                                                                                                                                                                                      |
| Water management and consumption                                   | At the mine, sedimentation dams are constructed to prevent release of sediments from the mining area into local watercourses. The dams are constructed to standards consistent with the requirements of the IFC. Regular monitoring of suspended solids and other water quality parameters is carried out downstream of the dams. Water levels in the TSF are controlled by decanting clear water to an ocean outfall or by water recycling to the plant site.<br>The total water consumption in 2022 was around 27 million m <sup>3</sup> . Water for various processes is withdrawn from a variety of sources at the mine, plant and port facilities. The water stress level at the Ambatovy mine and the Taomisana plant is considered as low; riverine flood risk as extremely high. |



| ESG category                            | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pollution prevention                    | Low risk of acid mine drainage is indicated because of low sulphur contents of ore and waste rock. The tailings resulting from acidic leach at the refinery are neutralized by means of limestone before being disposed in the TSF.                                                                                                                                                                                                                                  |
| Air quality                             | Air quality data is collected from a fixed continuous air monitoring station and static perimeter multi-gas detectors located along the plant site boundary. In 2022, no emission incidents or daily criteria exceedances occurred.                                                                                                                                                                                                                                  |
| Tailings management                     | Tailings are generated at the plant site. After metal extraction, the neutralised residues are pumped as slurry to the TSF. The TSF has a spillway for the safe discharge of excess water in extreme storm events. The TSF will ultimately hold an estimated 220 Mt of residues, occupying an area not exceeding 773 ha and built to a height of 72 m.a.s.l. Upon plant closure the tailings area shall be reclaimed and revegetated.                                |
| Waste management                        | The principal wastes generated by AM include waste materials from construction, packaging and scrap, used oils, ash and other by-products, overburden from mining operations, tailings generated by the processing plant and domestic waste and sewage. Waste rock and overburden from the mine has no potential for AMD, the overburden and waste rock is used to backfill the mined out voids if possible.                                                         |
| Hazardous materials management          | Chemical waste is neutralized on site. Paints, lubricants, used oil filters and hydrocarbon waste are recycled and treated by local companies.                                                                                                                                                                                                                                                                                                                       |
| Noise and vibration                     | Noise monitoring campaigns are carried out at the mine, port and plant sites, and in surrounding communities. The majority of noise pollution at the mine comes from the heavy vehicle traffic and the power plant. At the plant, there are a variety of sources of noise pollution, from vehicle traffic and operational activities of the facilities themselves.                                                                                                   |
| Protected areas and biodiversity        | The boundary of the mining concession is located around 6 km from the Mantadia national park that is categorized as IUCN Management Category II. The company applies the mitigation hierarchy, as required by the IFC Performance Standard 6, and adheres to the principles of the Business and Biodiversity Offsets Program Standard. Additional conservation actions may further compensate for the impacts on biodiversity.                                       |
| Mine closure                            | AM is committed to rehabilitation of the property following exploitation. A Reclamation and Closure Plan has been prepared by consultants and is in place for all aspects of the project. Mined areas shall be reclaimed and rehabilitated as mining proceeds. The cost of mine site remediation and reclamation is estimated at US\$ 100m. Products of forest clearing (topsoil, plant debris) are processed and stockpiled for future mine rehabilitation actions. |
| <b>Social and socio-economic issues</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Community health, safety and security   | AM develops plans, to protect the public, the environment and infrastructure in the event of a significant incident. The company also has developed a risk management to limit the severity of impacts, should an incident occur and works in partnership with regional authorities to reinforce local capacity in emergency preparedness and response.                                                                                                              |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dialogue and engagement with communities and stakeholders | The Communities and Social Relations program of AM focuses primarily on livelihoods development, the implementation of projects supported through the Social Investment Fund, community health and safety, work with resettled families, community engagement and cultural heritage.                                                                                                                                                                                                    |
| Land acquisition and involuntary resettlement             | From December 2007 to February 2008, villagers living in the vicinity of the TSF and plant site were resettled into two communities. The company claims that it continues to be active in these communities, collaborating closely with community members to identify sustainable, community driven projects.                                                                                                                                                                           |
| Occupational health & safety management                   | AM claims that it has developed a robust Health and Safety department with the support and involvement of all departments and employees. Employees are required to complete general training on health and safety, first aid, environmental rules and regulations, labelling of hazardous material, safety documentation, and firefighting.                                                                                                                                             |
| Workers' rights                                           | AM makes commitments to fair treatment for every employee and claims that it respects the Malagasy labour code as well as the ILO labour standards. According to the Labour Rights Index in Madagascar only limited access to decent work is found.                                                                                                                                                                                                                                     |
| Gender and diversity                                      | AM claims that it is, providing employment opportunities for women in a typically male dominated industry                                                                                                                                                                                                                                                                                                                                                                               |
| Local value added and community development               | In-country beneficiation, job creation and community development policies and programmes are in place; the project has considerable economic impacts at all levels. AM tracks its “economic benefit footprint”, which includes payment of taxes and royalties to the government;                                                                                                                                                                                                        |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Legal compliance                                          | Relevant licences are available. No indication of breaches of law found.                                                                                                                                                                                                                                                                                                                                                                                                                |
| Management practices                                      | AM states that it is committed to responsible business practices and to comply with national regulations and international standards for environmental and social management, and other business practices.                                                                                                                                                                                                                                                                             |
| Transparency and reporting                                | Under the terms of the lending agreement, AM is required to adhere to stringent national and international standards for environmental management, social engagement, and other business practices. These standards include the Equator Principles and the World Bank Group’s International Finance Corporation Performance Standards. AM is audited several times per year by independent third-party experts who report to the lenders and is part of the EITI report for Madagascar. |
| Business ethics                                           | The company is committed to consider interests of all stakeholders in decision-making, and states respect for culture, customs, values and human rights in interaction with affected stakeholders. The tools implemented are Business Ethics Code, Anti-Corruption Policy and Human Rights Policy. Madagascar is not considered as conflict-affected and high-risk areas under the EU conflict minerals regulation. Madagascar ranks 145 out of 180 on the corruption perception index. |

Table 67. ESG features of the Ambatovy project, Madagascar

### 5.1.4 Infrastructure assessment

#### Potential Investment Needs:

- Renewable Energy Ventures: Investments can be made in climate neutral energy production. A local 40 MW<sub>p</sub> solar project with 5 MWh storage facility would cost ca. US\$ 11m. To meet 120 MW power demand, costs of approximately US\$ 30m can be expected.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | The mine site is located at Ambatovy 80 km east of Antananarivo, the capital of Madagascar, near the town of Moramanga. The mine is only a few kilometres from the road and rail networks that connect it to the port city of Toamasina (220 km), on the east coast, where the ore preparation plant and tailing plant are located.                                                                                                                                                                                                                                                                                                                                                                                             |
| Transport                 | An 11 km access road has been built from the mine site to the national road RN44, which leads to Moramanga, the nearest town to the mine. The access road is graveled and 9 m wide. It is maintained on a regular basis by a contract service crew. Several haul roads, 8 km long, have been built to link the ore preparation plant and TSF with Toamasina. The roads are graveled and 25 m wide and capable of transporting Ambatovy project loads to the port. The ore from the mine is transported to the ore preparation plant by way of an approximately 220 km pipeline.                                                                                                                                                 |
| Airport                   | Moramango Ambohibary Airport is a private airport managed by Ambatovy company and situated 1 km from the town of Moramanga, 50 km from the mine. Access road to use from the airport is RN11a that joins RN2. An 883 m long and 20 m wide airstrip has been constructed that will allow private aircraft access to the mine.                                                                                                                                                                                                                                                                                                                                                                                                    |
| Rail access               | A 1 m gauge railway line that runs from Antananarivo to Moramanga and to the port of Toamasina was recently privatised and has been upgraded. The rail can be used alternatively for material transport. An approximately 2 km long double-tracked rail spur has been constructed to connect the existing rail line leading to the port with the ore preparation plant.                                                                                                                                                                                                                                                                                                                                                         |
| Port                      | All material imports and exports are done through the port of Toamasina. For this, Mole B has been expanded to meet the Ambatovy Project requirements. The Mole B extension is 256 m long and 32 m wide with the addition of a mooring dolphin, projecting approximately 350 m beyond the north end of the extension. The structure is equipped with fenders and bollards suitable for 50,000 dwt class bulk carriers. A dedicated ammonia offloading terminal has been included in the Mole B expansion.                                                                                                                                                                                                                       |
| Energy                    | Ambatovy Nickel power station is a three-unit coal-fired power plant with a total capacity of 120 MW, powering the operations of the Ambatovy nickel mine. The plant was completed in 2011 and was originally owned by a joint venture of Sherritt International, Sumitomo, Korea Resources Corp. (KORES), and SNC-Lavalin.                                                                                                                                                                                                                                                                                                                                                                                                     |
| GHG emission              | In 2022, Ambatovy launched a “decarbonization journey” to lower carbon emissions and reduce its emissions footprint. The first phase of this program focused on updating the GHG emissions calculation and reporting tools, in alignment with the IPCC, and on identifying new decarbonization strategies and abatement measures. Ambatovy’s overall GHG emissions in 2022 for the mine, plant, and port facilities were estimated at a combined total of 1,931 kt of CO <sub>2</sub> -eq. At the plant site, coal, used for electrical power and steam generation, remained the primary source of GHG emissions. At the mine site, the main source of GHG emissions is diesel fuel. Investments can be made in climate neutral |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       | energy production to reduce the dependencies on fossil fuels. With an average of 2,000 kWh/m <sup>2</sup> /year, Madagascar is among the richest countries in solar energy potential in Africa, making it a stand-out candidate for renewable energy investments. Furthermore, hydropower is currently responsible for approximately half of Madagascar's power supply, making it another viable contender. Implementation and integration of renewable energy sources need to be assessed case-by-case.                                                                                                                                              |
| Water | The Mangoro River, approximately 20 km west of the mine, has significant flow throughout the year. The Ambatovy Joint Venture constructed a 24 km long pipeline (6,000 mm diameter) to bring water from the Mangoro River water to the mine as required for its operations. The Ivondro River pump station provides all the necessary raw water requirements for the ore preparation plant, taking into consideration the reclaim and tailings pond return waters available from the ore thickener and tailings pond, respectively. The water is treated at the process water plant, to produce process water, demineralised water and potable water. |

**Table 68. Infrastructure assessment of Ambatovy project, Madagascar**

### 5.1.5 Further reading

Ambatovy Minerals S.A (2023): Sustainability Report 2022. <https://ambatovy.com/en/wp-content/uploads/2023/09/Ambatovy-Sustainability-Report-2022-EN.pdf> (accessed 18.09.23)

CSA Global (2018): NI 43-101 Technical Report - Ambatovy Nickel Project, Madagascar. [https://minedocs.com/20/Sherritt International Corp Ambatovy Nickel Project TR 06302018.pdf](https://minedocs.com/20/Sherritt%20International%20Corp%20Ambatovy%20Nickel%20Project%20TR%2006302018.pdf) (accessed 18.09.23)

European Investment Bank (2018): Ambatovy Nickel Project, Complaint SG/E/2012/04 – Conclusions Report. European Investment Bank Complaints Mechanism. <https://www.eib.org/attachments/complaints/2018-03-19-sg-e-2012-04-ambatovy-conclusions-report-en.pdf> (accessed 7.5.2024)

## 5.2 Konkola sediment-hosted Cu project (Zambia)

Information as of 12/2023

### 5.2.1 General project background

|                                 |                                                                                                                                                                                                          |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Copper                                                                                                                                                                                                   |
| <b>Other commodities</b>        | Cobalt (potentially)                                                                                                                                                                                     |
| <b>Location</b>                 | Copperbelt, Zambia<br>12°23' S, 27°50' E, 1,250 – 1,400 m.a.s.l.                                                                                                                                         |
| <b>License type</b>             | Large-scale mining and processing licenses: Konkola, Chingola and Nchanga                                                                                                                                |
| <b>License owner / operator</b> | Konkola Copper Mines Pls. (79.4 % Vedanta Resources Ltd. (private company); 20.6 % ZCCM Plc (Zambia gov.))                                                                                               |
| <b>Contact</b>                  | 30 Berkeley Square<br>London, W1J 6EX, United Kingdom<br><a href="http://kcm.co.zm/">http://kcm.co.zm/</a><br><a href="mailto:corporate.communications@kcm.co.zm">corporate.communications@kcm.co.zm</a> |
| <b>Project status</b>           | Production – Expansion                                                                                                                                                                                   |
| <b>Production by 2030</b>       | Possible                                                                                                                                                                                                 |

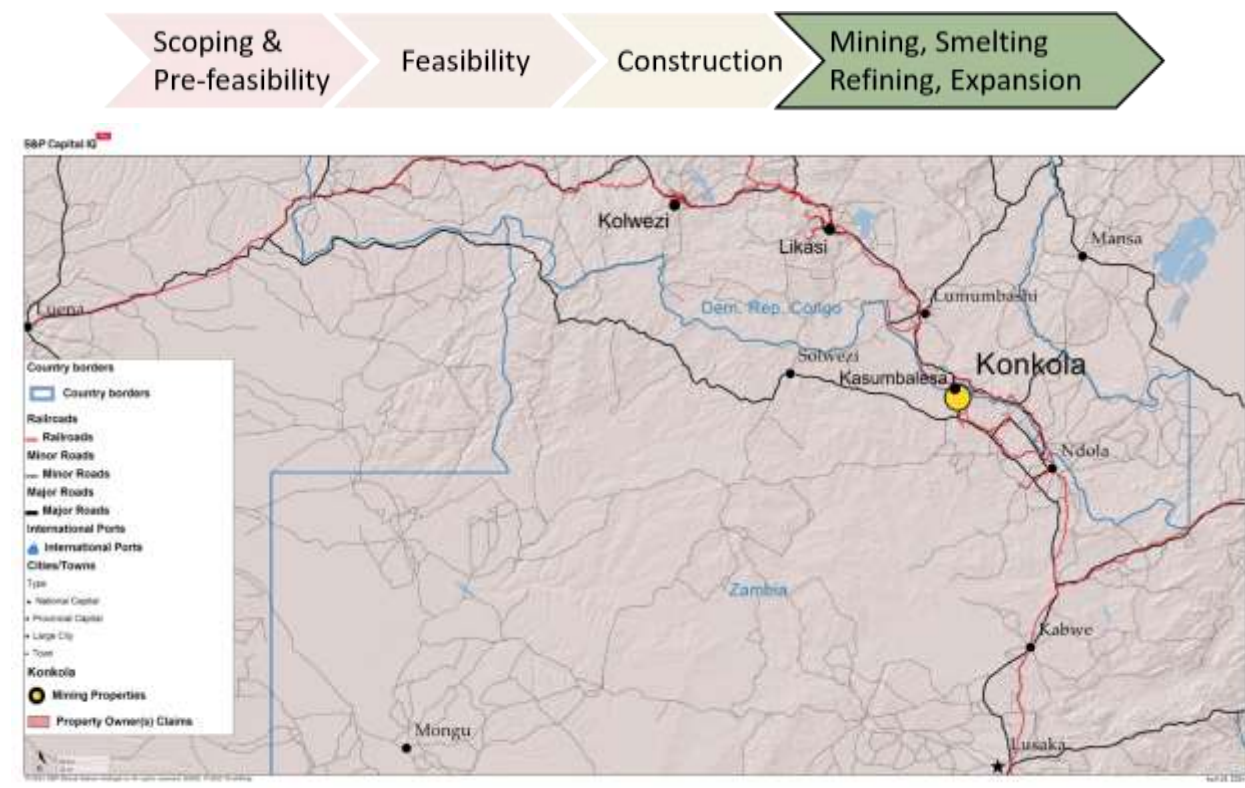


Figure 51. Konkola project location, Zambia

## 5.2.2 Economic assessment

### General project background:

The Konkola mine commenced production in 1957 and mining operations have historically been focused on two existing shaft systems, No. 1 shaft and the No. 3 shaft. The mine is currently owned by Konkola Copper Mines (KCM), which exploits the Chililabombwe orebody by underground methods. In June 2006, the company commenced sinking the No. 4 shaft in the Chililabombwe South ore body as a part of its Konkola Deep Mine project. The project comprises the underground mine and the Konkola east and west concentrators. The Konkola mine is characterised by three stratiform ore bodies, which occur within slightly dolomitic siltstones with a thickness of 4-15 m, which dip 10-75° and are hosted by a warped basin with a length and width of 14 km and 3 km, respectively. The dominant features of the mine are the Chililabombwe Anticline in the southeast and the Konkola Dome in the northwest. Currently, KCM is undertaking the Konkola Deep Mining Project, which aims to access the orebody underlying the previous operations. This involved the sinking of a new mine shaft to the depth of ~1.5 km. The owner seeks investment for infrastructure completion at Konkola Deep and mine development to ramp-up production. This also includes the commissioning of a 6 Mt/a concentrator.

### Project description:

|                                    |                                                                                                                                                                                 |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Stratiform, sediment-hosted copper deposit                                                                                                                                      |
| JORC compliant Reserves            | 224 Mt @ 1.18 % Cu                                                                                                                                                              |
| Share of global copper reserves    | 0.3 % ( <i>USGS estimate global Cu reserves of 890 Mt</i> )                                                                                                                     |
| JORC compliant resources           | 468 Mt @ 2.70 % Cu                                                                                                                                                              |
| Share of global copper resources   | 0.6 % ( <i>USGS estimate global Cu resources of 2100 Mt</i> )                                                                                                                   |
| Waste to ore ratio (whole orebody) | Low, due to underground mining methods                                                                                                                                          |
| Annual production                  | Pre-expansion: 130 kt of Cu; 2022: 1.4 Mt of ore, 33 kt of Cu<br>Post-expansion: 7.5 Mt of hoisted ore, 311 kt of smelted Cu from own concentrates and third party concentrates |
| Life of mine                       | Post-expansion: 30 years                                                                                                                                                        |
| Investment required                | Not specified                                                                                                                                                                   |
| Net present value (NPV)            | Negative before upgrade of mining, processing and smelting                                                                                                                      |
| Share of global copper production  | 1.4 % (311 kt of Cu/a, recovery 77 %)<br>( <i>USGS estimate global Cu production of 22 Mt</i> )                                                                                 |
| Value addition potential           | The company owns a tailings leaching plant, which is fed with sulphuric acid produced at the company-owned smelter. Surplus acid is sold within and outside Zambia.             |

### Mining and processing:

- The Konkola mine is situated in Chililabombwe, approximately 26 km north of Chingola, which is located on the main national highway (T3) between Lusaka and the DR Congo. Power is supplied via the national grid (Copperbelt Energy Corporation Plc.). Water is supplied via the Kafue River and the drained underground mines.



- The deposit is a high-grade, medium-tonnage operation with a low waste to ore ratio due to underground mining methods. The relatively long life of mine (30 years) is positive for regional development. Further resource expansions are possible due to the occurrence of several small satellite pits, which also include surface-near oxide deposits and in general, new discoveries might be made due to the large size of the prospective basin and its known copper potential.
- Underground mining is employed using panel caving, post pillar cut and fill, sub-level open stoping and backfilling. The shafts No. 1 and No. 2 are equipped for hoisting ore (3.15 Mt/a) and waste (1.85 Mt/a). Commissioning of shaft No. 4 would increase the total capacity to 7.5 Mt/a.
- The ore is crushed, milled and floated through a conventional sulphide flotation plant, planned to process 6 Mt/a of ore to copper concentrate (35 % Cu grade). The company-owned Nchanga smelter smelts concentrates from Konkola, Nchanga and third parties and has a capacity to produce 311 kt of copper. The copper recovery rate is ~77 %. The cobalt is part of a copper-cobalt alloy product and sold to markets mainly in Asia. Besides the smelter, the company owns the Nchanga tailings leaching plant, which uses the majority of produced sulphuric acid from the smelter and produces copper cathodes from concentrate solution via electrolysis. Surplus acid is sold to customers within and outside Zambia. A final by-product of the refinery process is anode slimes or sludge, which is exported under long term contracts to third parties for the recovery of precious metals, such as silver, platinum and palladium by the electro-refining process.
- The all-in costs (including the provisions for the development and expansion CAPEX) in 2022 were modelled by S&P at US\$ 9.92/kg of copper, extremely high compared to the average copper sales price of around US\$ 8.50/kg. The reason for the high specific copper costs are the high mining costs that cause about 75 % of the total costs.
- In 05/2019, due to unpaid invoices of Konkola's suppliers and contractors, and technical aspects of the operations, the Zambian government took over Vedanta's assets from Konkola Copper Mines and forced liquidation. In 09/2023, Vedanta announced that the ownership and management of Konkola has been returned to the company by committing to a payment of US\$ 250m to local creditors and committing US\$ 1bn as CAPEX for mine development.

#### **BGR assessment and comments:**

- The project management identified the outdated underground mine infrastructure as cost driver and plans investments in modernising the mine infrastructure, including the sinking of high capacity shafts that could increase the ore production from ~1.4 to 6.5 Mt/a. A modelled reduction of labour and electricity costs by 30 % would decrease the all-in costs to ~US\$ 7.00/kg of copper. This would be slightly below of the average sales price of around US\$ 8.50/kg. Nevertheless, Konkola would remain a high-cost asset in the global copper sector.

### 5.2.3 ESG assessment

Vedanta provides little information regarding the ESG situation at KCM. A Technical Report is dating back to 2005 (and names several legacy environmental issues). Although several issues have been solved, there is no information available regarding GHG emissions, SO<sub>2</sub> or NO<sub>x</sub> emissions from the smelter, waste or tailings management or any other information concerning ESG, later than 2005. It is unclear to what extent Vedanta Resources is responsible for managing mining legacy sites. The most relevant environmental issues might be related to tailings.

When investing in the asset it is recommended to not only focus on the underground mine and the processing facility, but to address the issue of a proper closing plan for the open pits, the mine waste dumps and of constructing a new tailings storage facility according to internationally recognized tailings dam construction and management standards. Another relevant issue are legacies as the site has a long mining and processing history and thus many legacy environmental issues. However, since Vedanta acquired KCM, action has been taken to address many of the inherited environmental issues. The website of KCM was not accessible at the time of the assessment, thus ESG information related to Konkola beyond general company information on Vedanta is limited.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Environmental management                                           | There is no information on the environmental management system or ISO certification. During the history of KCM operations the Zambian legal requirements as well as the IFC / World Bank policies and guidelines have had an important role in the environmental and social planning of the mining operations. Required to have an Environmental and Social Action Plan.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Efficient use of energy, renewable energy, GHG emissions reporting | New smelter has reduced fossil fuel consumption by 70 %. No information about GHG emissions available. Power from Zambian grid (85 % hydropower).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Water management and consumption                                   | Water stress in the Copperbelt area is generally low. In 2005 KCM recorded high concentrations of total suspended solids (from underground mine dewatering) in mine water that was discharged into the Kafue River, due to the lack of storage space and settling capacity at the mine. Nchanga and Konkola were equipped with new machinery to achieve zero water discharge from process water (concentrator and smelter). Prior to 2019 (when production was halted) 375,000 m <sup>3</sup> of water per day were pumped from the underground operations. The water goes through settling and sedimentation prior to disposal into the Kafue River where it provides a constant baseflow year-round and throughout the dry season. KCM aims to develop an irrigation system downstream, enabling farmers to benefit from the constant baseflow created by the dewatering works. |
| Pollution prevention                                               | 2,577 Zambian farmers took legal action in the UK against UK-based Vedanta Resources and its Zambian subsidiary Konkola Copper Mines for                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| ESG category                                                                                             | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | damage to their land and waterways from copper mining effluent and emissions. The lawsuit was settled in 2021 “without admission of liability”. The settlement amount was not disclosed. The open pits and waste rock piles to the North and West of the City of Chingola show strong weathering. There is no indication that pit and dump slopes are flattened or stabilized. According to the BBC, Vedanta settled a pollution claim in 2021 concerning a dispute from 2015 with villagers (according to the BBC caused by a spill of sulphuric acid and other toxic chemicals). |
| Air quality<br>         | Commissioning a new smelter increasing sulphur capture efficiency to >99.6% (2008) and increasing energy efficiency. No information about processing plant, tailings, waste rock, or emissions from smelter available.                                                                                                                                                                                                                                                                                                                                                             |
| Tailings management<br> | Several tailings ponds of different ages, partly strong erosion visible on the dams. Unclear where and how the tailings from Konkola Deep would be deposited. According to satellite images, the tailings are located very close to larger settlements and farming activities around the TSF, including the downstream areas of the tailings dam. Several rivers and creeks enter the dam facility. The runoff water from the tailings dam is released via a spillway to a downstream drain, without any visible water treatment.                                                  |
| Waste management                                                                                         | In 2005, KCM published a report stating that on-site solid waste separation would take place, but the contractor collecting the waste remixed it prior to disposal; waste oil storage in the concentrator took place without bunding or impervious surfacing; no further information available.                                                                                                                                                                                                                                                                                    |
| Hazardous materials management                                                                           | No information available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Noise and vibration                                                                                      | No information available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Protected areas and biodiversity                                                                         | Mine not located in or close to any key biodiversity or designated protected area.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Mine closure                                                                                             | Closure obligations difficult to assess because of legacy sites. Vedanta estimated closure costs to be at minimum US\$ 100m for all legacies at KCM in 2005, but this might still be underestimated.                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Social and socio-economic issues</b>                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Community health, safety and security                                                                    | Malaria control program of the company since 2000 that focuses on indoor residual spraying within a 10 km radius of the inhabited area in Chingola, Chililabombwe and Nampundwe implemented in partnership with the community and the Ministry of Health through the National Malaria Control Centre (NMCC) and District Health Management Team.                                                                                                                                                                                                                                   |
| Dialogue and engagement with communities and stakeholders                                                | No information on structured dialogue procedures available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Land acquisition and involuntary resettlement                                                            | Resettlement of 86 families due to cracks in houses related to mining activities. The direct responsibility of the company is difficult to assess, as mining has been carried out in the area for several decades.                                                                                                                                                                                                                                                                                                                                                                 |
| Occupational health & safety management                                                                  | Information from 2005: OHS was audited by the British Standards Institute and BSC; OHSAS 18001 Certification was due to start in 2005.                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| ESG category                                | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Workers' rights                             | KCM claims to recognise and respect employee rights for free association and collective bargaining, and claims to promote fair working conditions. According to the Labour Rights Index, Zambia scores 66.5 out of 100, equivalent to “limited access to decent work.”                                                                                                                                                                                                                                            |
| Gender and diversity                        | KCM states to be an equal opportunity employer and endeavours to provide opportunities for women in all fields including engineering science and technology.                                                                                                                                                                                                                                                                                                                                                      |
| Local value added and community development | Several disputes about taxes and royalties with state authorities and a dispute about US\$ 250m that Vedanta allegedly owes suppliers in Zambia. These issues were resolved in 2023. KCM claims that it is an integrated mining, concentrate production, smelting and refining company, adding value to the mine products in Zambia. Installation of solar-powered community water boreholes including a water distribution-piping network for local communities to ensure a continuous supply of drinking water. |
| <b>Governance</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Legal compliance                            | Zambia took action against KCM due to unpaid taxes and royalties, and unpaid bills to national suppliers (recently resolved). Dispute around the expansion of the Konkola deep mine project.                                                                                                                                                                                                                                                                                                                      |
| Management practices                        | Only limited information available for KCM, as website is not accessible. ESG company policies, safety standards and technical standards available on the general Vedanta website.                                                                                                                                                                                                                                                                                                                                |
| Transparency and reporting                  | Vedanta Resources is reporting production and payments to Zambia via EITI. Vedanta Resources is a public limited company, meaning not stock listed, with headquarters in London, owned by the Indian billionaire Anil Agarwal.                                                                                                                                                                                                                                                                                    |
| Business ethics                             | Konkola Copper Mines is not located in a high-risk area; Zambia scores 37 out of 100 points in the corruption perceptions index (rank 116 of 180); Vedanta Resources has a relatively poor track record of incidents with various issues in Zambia and India, although there has apparently been substantial improvement at Konkola Copper Mines.                                                                                                                                                                 |

Table 69. ESG features of Konkola project, Zambia

### 5.2.4 Infrastructure assessment

#### Potential Investment Needs:

- Road Infrastructure: Investment opportunities to upgrade the trunk roads linked to site.
- Railway Enhancements: Developments needed to reconstruct, maintain, and improve rail conditions (e.g., Ndola to Luanshya Line).
- Renewable Energy Ventures: Investment opportunities to establish strategically located power stations with respect to the site location and operations, as well as to build or connect with nearby renewable energy sources (hydro energy).

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | The Konkola mine, owned by KCM, is situated in Chililabombwe, approximately 26 km north of Chingola. It is the most northerly mine of the Zambian Copperbelt. The infrastructure for the project is now mostly complete and mine development to ramp-up production is underway.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Transport                 | Road infrastructure surrounding the site consists of highways and national roads. The site can be accessed through the trunk road (highways), T5 and T3. The location of the site can also be accessible through a national road, N1, connecting Zambia and DRC. Trunk roads are commonly sealed, whereas primary roads (national highways) consist of varying sealed and unsealed segments.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Airport                   | Zambia has four international airports and forty-six aerodromes. Konkola mine is located 29.8 km away from the Kasompe Airport and 133 km away from the Simon Mwansa Kapwepwe International Airport. Zambia has no national airline but is served by a number of airlines that are connected to international routes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Rail Access               | The project lies 23.5 km to Chingola Railway Station. Zambia's main railway lines are the Zambia Railways and the TAZARA line, which links Zambia with Tanzania. Zambia is connected to the port of Nacala and railway networks of Malawi and Mozambique by the Chipata-Mchinji railway link.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Port                      | Zambia has seven inland ports. The Tazara Dry Port is the major logistics center for the eastern and central corridors, allowing direct rail transfer of cargoes to and from Dar es Salaam seaport. The dry port spans 4 ha of ground. It contains two heavy-duty weighbridges for port vehicles, sophisticated equipment for handling containerized goods, warehousing facilities for holding general freight and breakbulk, and a gantry crane. Rail freight handling, de-stuffing, and containers are provided here.                                                                                                                                                                                                                                                                                                                                                                                                      |
| Energy                    | Energy infrastructure (power plants and transmission lines) is established in both nations. The Zambian Copperbelt region in particular exhibits numerous power plants with outputs ranging from 10 MW – 1000 MW. Power plants in the southern region of DRC are generally of smaller capacity and more scarcely distributed. The projects will require large power capacity which will likely not be sustained from the nation grid(s). Implementation and integration of renewable energy sources need to be assessed case-by-case.                                                                                                                                                                                                                                                                                                                                                                                        |
| GHG Emission              | To curb CO <sub>2</sub> emissions and reduce power grid dependencies, investments should be directed towards expanding renewable energy sources such as hydro plants and solar farms. Moreover, already existing hydro plants can be linked to the site. For example, DRC's main energy resource is hydroelectricity, with a very large potential of around 100 GW (30 % of the African continent, located on the Congo River and its tributaries, with more than 40 % of that potential situated on the site of Inga). So far, only 3 % of this hydroelectric potential has been developed, which nevertheless accounts for 96 % of domestic power generation. Similarly, Zambia has 2,800 MW of installed electricity generation capacity, of which 85 % is hydro based. The Konkola project should harness the largely untapped hydro renewable energy market to establish sustainable and reliable local power networks. |
| Water                     | The Konkola mine is one of the wettest mines in the Zambian Copperbelt, with inflow volumes of approximately 400,000 m <sup>3</sup> /d. The water from all pump stations is channelled through sumps for settling and sedimentation before it is pumped to the surface for discharge into the Kafue River.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

**Table 70. Infrastructure assessment of Konkola project, Zambia****5.2.5 Further reading**

Dzimunya N., Radhe K., William C.M. (2018): Design and dimensioning of sublevel stoping for extraction of thin ore (< 12 m) at very deep level: A case study of Konkola Copper Mines (KCM), Zambia. Mathematical Modelling of Engineering Problems. 5(1):27-32.

[https://www.researchgate.net/publication/324590798\\_Design\\_and\\_dimensioning\\_of\\_sublevel\\_stoping\\_for\\_extraction\\_of\\_thin\\_ore\\_12\\_m\\_at\\_very\\_deep\\_level\\_A\\_case\\_study\\_of\\_konkola\\_copper\\_mines\\_kcm\\_Zambia](https://www.researchgate.net/publication/324590798_Design_and_dimensioning_of_sublevel_stoping_for_extraction_of_thin_ore_12_m_at_very_deep_level_A_case_study_of_konkola_copper_mines_kcm_Zambia) (accessed: 19.12.2023)

IMC Group Consulting Ltd. (2005): Technical Assessment Report of Konkola Copper Mines Plc. as at 12th August 2005. <https://miningdataonline.com/reports/Konkola-Copper-Mines-Plc-8122005-TR.pdf> (accessed: 19.12.2023)

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Vedanta Resources Plc. (2018): Investor Presentation. [https://www.vedantaresources.com/InvestorReports/fy18\\_vedanta\\_plc\\_presentation\\_23\\_may\\_vf1.pdf](https://www.vedantaresources.com/InvestorReports/fy18_vedanta_plc_presentation_23_may_vf1.pdf) (accessed: 19.12.2023)

ZCCM Investments Holdings Plc. (2023): Further reZCCM-IH Cautionary Announcement on KCM. <https://markets.ft.com/data/announce/full?dockey=1323-16198049-4QBFH8LT3VS3LTIDF82GA8UHT0> (accessed: 19.12.2023)



## 5.3 Leaching plant for artisanal Cu ore (Tanzania)

Information as of 01/2024

### 5.3.1 General project background

|                           |                                                                                                                 |
|---------------------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>  | Copper                                                                                                          |
| <b>Location</b>           | Tanzania                                                                                                        |
| <b>Owner / operator</b>   | Conceptual proposal without actual operator                                                                     |
| <b>Project status</b>     | Conceptual proposal to increase ASM value addition                                                              |
| <b>Production by 2030</b> | Possible (ASM copper mining already on-going; setting up a small-scale leaching plant could be relatively fast) |

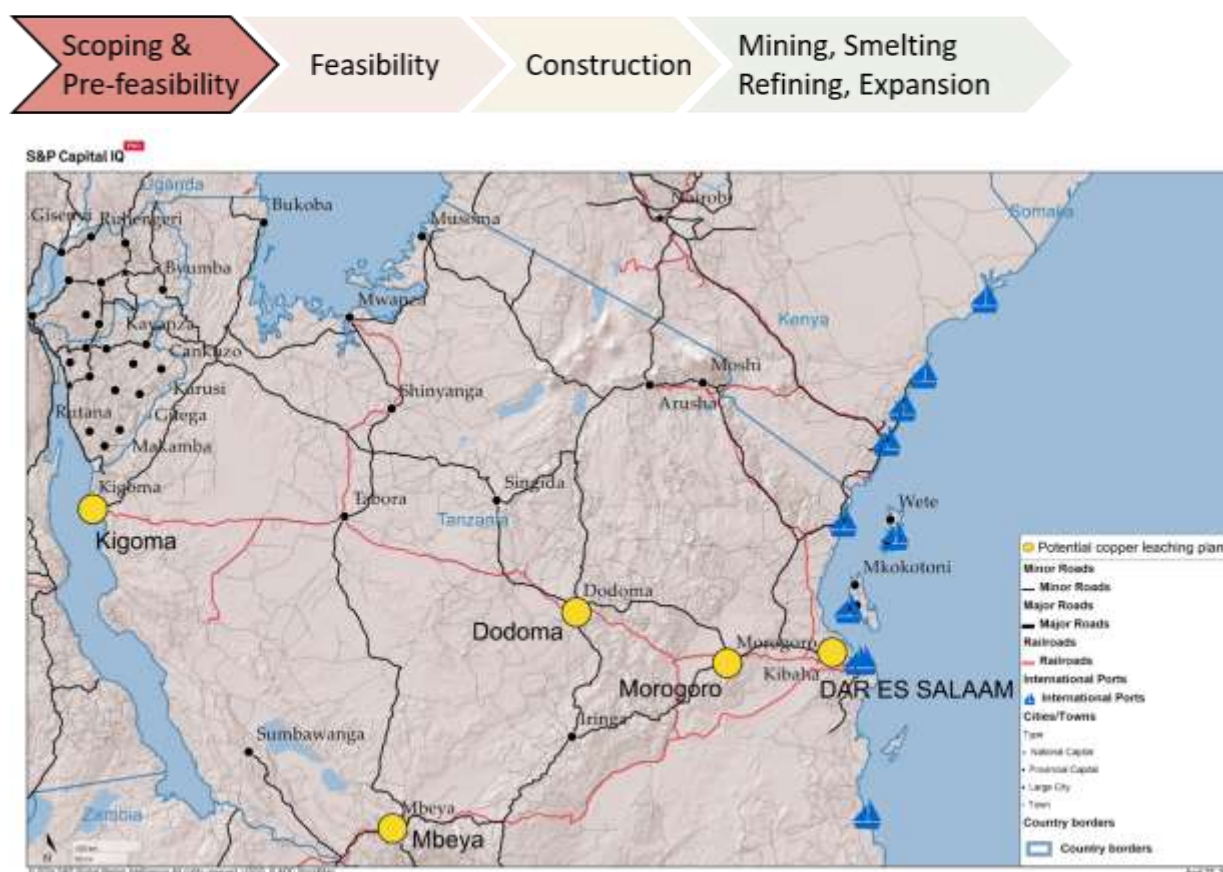


Figure 52. Favourable locations for a possible leaching plant for artisanal copper ore, Tanzania

### 5.3.2 Economic assessment

#### General project background:

There are 39 active and inactive mining sites registered in the Tanzanian geo-economic database, where copper has been mined as main commodity or by-product. Currently, 18 large-scale mining licences for copper and more than 1,000 primary mining licences (small-scale mining) for copper are recorded at the licence database of the Geological Survey of Tanzania (GST). The regions with active mining zones are located in Rubeho Mountains between Dodoma and Morogoro and on the Ufipa Plateau that starts on the eastern flank of the rift valley. Smaller mining zones are close to the border to Mozambique in the south and close to Lake Victoria in the north. BGR estimates that Tanzania has the capacity to produce at least 10,000 t of copper content from ASM mining operations. There have been attempts to process ASM copper ore in Tanzania, but currently there is no such plant active in Tanzania. It is likely that much of the ore is exported as direct shipping ore. Since ASM operations are mainly producing high-grade oxide copper ore/hand picked concentrates, a leaching plant would be an option to add value to the ASM copper production. In the past, it was reported that some efforts from Chinese investors have been made to leach copper ores at a small scale. However, a medium scale copper leaching plant, as for example constructed in Chile by ENAMI at El Salado with a capacity of 800 t of cathode copper per month, seems to be a more adequate concept that could to be adopted in Tanzania.

There are three options to process oxide copper ore from small-scale mining operations. These involve different scales of investment and have different technical aspects: The marketing of (1) copper sulphate and (2) copper precipitate (cement copper) is possible for small businesses that want to minimise investment and transport costs. However, the final product of copper processing would be cathode copper. Thus, the added value to these products has not yet been exploited. Larger companies have the third option of produce (3) cathode copper through electro winning in a central plant that either buys copper ore from small-scale mining operations or processes it on behalf of the miners for a processing fee. Through the production of high-quality cathode copper, small-scale mining in East Africa would gain direct access to the global copper market and could benefit from the added value and current high copper price. In the following context, option 3 will be presented in more detail as a business case.

As a basis for conceptual illustration of the business case for a central copper leaching plant in Tanzania, a possible annual supply from small-scale mining of around 75,000 t of oxide copper ore with around 10,000 t of copper content is assumed. This corresponds to an average copper grade of around 15 % (at 90 % recovery), which is a typical grade for ASM direct shipping ore for example in the DRC copperbelt. The ore would be delivered to the central plant by trucks from different ASM copper mining sites in Tanzania. After crushing, the copper ore can be leached either in tanks or in heaps.

**Assumed operational and financial parameters:**

|                                                                 |                                                               |
|-----------------------------------------------------------------|---------------------------------------------------------------|
| Ore deposit type                                                | Secondary enrichment zones of copper deposits                 |
| Annual ore throughput                                           | 75,000 t @ 15% Cu (average grade), minimum grade 1.5-2% Cu    |
| Annual Metal production                                         | 10,000 t of copper cathodes (at 90% recovery rate)            |
| Lifetime of the project                                         | > 5 years                                                     |
| Required CAPEX for SX-EW plant with 800 t/m Cu cathode capacity | Estimated US\$ 20m (for a direct winning plant probably less) |

**Consumables**

|                                       |                      |
|---------------------------------------|----------------------|
| Consumption of sulphuric acid         | 50 kg per ton of ore |
| Price sulphuric acid @plant gate      | 100 US\$/t           |
| Energy electrowinning                 | 2,500 kWh/t Cu       |
| Price per kWh at plant                | 0.12 US\$/kWh        |
| Other (e.g. lime, wear parts, diesel) | 100 US\$/t Cu        |

**Staff and workforce**

|                           |                            |
|---------------------------|----------------------------|
| University graduates (10) | 15,000 US\$/a average wage |
| Workers (70)              | 5,000 US\$/a average wage  |

**Financial parameters**

|                                   |              |
|-----------------------------------|--------------|
| Copper price                      | 8,000 US\$/t |
| Amortization of investment        | 5 years      |
| Required interest rate on capital | 15%          |
| Royalty on copper export          | 6%           |
| Income tax                        | 30%          |

**Processing:**

- For oxide copper ore with a copper content >1.5 %, tank leaching or heap leaching is the suitable hydrometallurgical process to extract the copper. The ore from the mining operation must be crushed and piled up on a leaching pad or fed into a leaching tank. The ore is then irrigated with dilute sulphuric acid, which is percolating through the heap for 2- 4 weeks, thereby leaching the copper contained in the ore minerals and bringing it into solution as dissolved copper sulphate. The copper-pregnant solution has to be cleaned, especially dissolved iron has to be precipitated and the pH value has to be adjusted for electrodeposition. If the copper concentration of the solution is >30 kg Cu/m<sup>3</sup>, direct electro-precipitation of the copper can take place on lead anodes. At a concentration of <5 kg Cu/m<sup>3</sup>, the copper in the solution must be pre-concentrated using solvent extraction before electrowinning can be applied. The cathode copper will have a grade of 99.9 % copper and can be sold directly to end users.

**BGR assessment and comments:**

- Possible uncertainties and commercial risks are linked to the ASM supply perspective (uncertainty in the annual delivery and compliance with internationally recognized ASM mining standards). Therefore, the plant management should support the supplying ASM sector by means of technical and ESG consultancy and take responsibility for the supply chain as required by supply chain due diligence.

- Based on a payback period of 5 years and a required interest rate of 15 % on the capital, the typical capital costs for a leaching plant would be around US\$ 5.5m/a.
- In the financial model, the annual costs for consumables like sulphuric acid, electricity and other cost items would be US\$ 0.375m, 3m and 1m respectively, and for the workforce US\$ 0.5m. This would result in total annual operational costs of US\$ 4.875m.
- The royalties paid to the government for the exported copper contents are US\$ 4.8m/a. The income tax depends on the taxable revenue/annual net profit, which are directly related to the net plant/smelter return (NSR), which is paid to artisanal miners upon delivery of the copper ore. In Tanzania there exists also the possibility to establish processing plants like the copper leaching plant under the Export Processing Zone/Special Economic Zone (EPZ/SEZ) schemes in order to obtain fiscal incentives. The results of a first economic pre-assessment realized by BGR are presented in the table below, describing 5 business cases with different net smelter returns to the ASM-sector.

The basic economic parameter for all considered cases of net smelter return are the same and summarized in the following table:

| Cu-leached t/a | Cu-price US\$/t | OPEX US\$/a | CAPEX US\$/a | Royalties US\$/a |
|----------------|-----------------|-------------|--------------|------------------|
| 10,000         | 8,000           | 4,875,000   | 5,500,000    | 4,800,000        |

**Table 71. Economic parameters assumed for the ASM leaching plant, Tanzania**

The return on investment – ROI (annual profit time 5 years / total investment of US\$ 20m) - of the model calculation for the business cases with varying net smelter return are presented in the following table:

| Case | NSR of Cu price | Taxable income/a | Income tax/a | Net profit/a | ROI  |
|------|-----------------|------------------|--------------|--------------|------|
| 1    | 73%             | \$6,425,000      | \$1,927,500  | \$4,497,500  | 112% |
| 2    | 75%             | \$4,825,000      | \$1,447,500  | \$3,377,500  | 84%  |
| 3    | 77%             | \$3,225,000      | \$967,500    | \$2,257,500  | 56%  |
| 4    | 79%             | \$1,625,000      | \$487,500    | \$1,137,500  | 28%  |
| 5    | 81%             | \$25,000         | \$7,500      | \$17,500     | 0.4% |

**Table 72. Business case comparison for the ASM leaching plant, Tanzania**

- The average value of net smelter return received for copper concentrate exports from Tanzania in 2022 is about 73 %.
- The return on investment, which calculated for a project lifetime of 5 years depends on the net smelter return paid to the ASM suppliers. A longer lifetime would increase the return on investment. When setting the net smelter return for the ore-buying scheme, it should be

considered that a higher net smelter return paid to the local ASM suppliers could have positive effects on the supply rate for the leaching plant.

### 5.3.3 ESG assessment

In consideration of the ESG issues of a possible leaching plant it should be clearly understood that this is a conceptual assessment, in which certain possible ESG impacts or risks are anticipated without these having already been assessed in detail. The recommendations for a possible project shall illustrate how the processes should be designed responsibly from an ESG perspective.

From an environmental perspective, an arid, sparsely populated region with low ecological value is preferred for the plant location to facilitate water management and to reduce the possible dilution of the acid by rainwater and minimize social and ecological impacts. Additionally, the physical stability of the heap would be increased in a dry environment. The leaching operation would benefit from access to clean surface water, otherwise it should be possible to use groundwater from a well field. If possible, the process should be designed without generating any wastewater that has to be discharged into receiving water bodies. This could be achieved by using water recycling. Discharged liquor with high concentration of possible water pollutants from the process should be evaporated in evaporation tanks (dry climate). The typical water consumption for copper leaching is about 0.1 – 0.25 m<sup>3</sup>/t of ore. In order to find the most suitable location at least the economic and environmental feasibility of three different locations should be investigated and compared.

The tailings dump constructed for the leached and neutralized tailings should have a sealed base. Rainwater that has come into contact with the leached ore as well as rainwater that drains from the ore stocks in the plant facility should either be captured and collected for further operational use or treated before discharge. Dust emissions should be avoided during ore crushing (e.g. by means of enclosure) and in transport activities (e.g. by means of moistening the gravel roads or by paving the ore pads and roads). The final tailings dump should be covered from early on to prevent the formation of dust. With a maximum height of the tailings dump of 5 m, its land consumption would be around 4 – 5 hectares after 10 years of operation, assuming a constant production level of around 75,000 t of ore annually.

From a social perspective, it would be important for the plant operator to establish a good long-term relationship with its ASM suppliers. This might take different forms, but should at least build on the concept of supply chain due diligence, where the plant operator has to evaluate the risks associated with its suppliers, understand the ESG impacts associated with their mining operations, and engages these suppliers for possible risk mitigation or training. Tanzania ranks 87/180 in the Transparency International Corruption Perception Index of 2021; Tanzania is an EITI country.

### 5.3.4 Site selection and infrastructure

The processing plant should be easily accessible from the mining regions via road or railway network. There should also be a connection to the local power grid. A connection with a maximum capacity of 10 MW should be sufficient. In Tanzania currently exist ten Government owned Special Economic Zones with Industrial Parks that are suitable for diverse industrial activities. Part of the electricity might come from a photovoltaic system, which would occupy an area of about 20 hectares (10 MW). The investment required for this photovoltaic system would be around US\$ 10m. However, with the plant's estimated power consumption, the payback period of the photovoltaic system could be around 3 years. This would significantly reduce the carbon intensity of the copper production.

Since the sulphuric acid has to be imported by sea freight (approx. 3,750 t/a) and the cathode copper has to be exported (approx. 10,000 t/a), being close to a port is advantageous for the leaching plant. With the disadvantage of long hauling distances for the copper ore. Additionally, sulphuric acid could also be delivered overland from Zambian or Congolese smelters or, in the future, could be produced in Tanzania by burning pyrite or sulphide concentrates in a local sulphuric acid plant.

Suitable locations for a central leaching plant can be found e.g. in the industrial zones of the cities of Dar es Salaam, Dodoma, Kigoma, Mbeya or Morogoro. Because of its international port of Dar es Salaam is favourable as logistic hub for the acid imports and cathodes export. The road and railway network that links the mining areas in Tanzania is aligned with Dar es Salaam. The other potential locations have access to the road and railway network and have the advantage that they are closer to the mining sites. The location in Kigoma has the additional advantage that copper ore and sulphuric acid could be imported via the Lake Tanganyika from the DRC and Mbeya is close to the copper mining sites in Zambia.

Next step could be a feasibility study evaluating the different options from an economic and ESG perspective (ESIA) in detail.

### 5.3.5 Further reading

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## 5.4 Manganese Metal Company, Nelspruit Plant – High Purity Manganese Sulphate Monohydrate project (South Africa)

Information as of 01/2024

### 5.4.1 General project background

|                           |                                                                                                                                                                                                                               |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>  | High Purity Manganese Sulphate Monohydrate                                                                                                                                                                                    |
| <b>Other commodities</b>  | Electrolytic Manganese Metal                                                                                                                                                                                                  |
| <b>Location</b>           | Mbombela, Mpumalanga, South Africa<br>25°27' S, 30°59' E, 675 m.a.s.l.                                                                                                                                                        |
| <b>License type</b>       | No mining activity                                                                                                                                                                                                            |
| <b>Owner / operator</b>   | Manganese Metal Company (Pty) Ltd (“MMC”)                                                                                                                                                                                     |
| <b>Contact</b>            | 15 Heyneke Street, PO Box 323, Mbombela (Nelspruit),<br>1200, South Africa<br><a href="http://www.mmc.co.za">www.mmc.co.za</a><br><a href="mailto:Madelein.todd@mmc.co.za">Madelein.todd@mmc.co.za</a><br>Tel: +27 13759 4600 |
| <b>Project status</b>     | Production (phase 1), expansion planned (phase 2)                                                                                                                                                                             |
| <b>Production by 2030</b> | Possible                                                                                                                                                                                                                      |

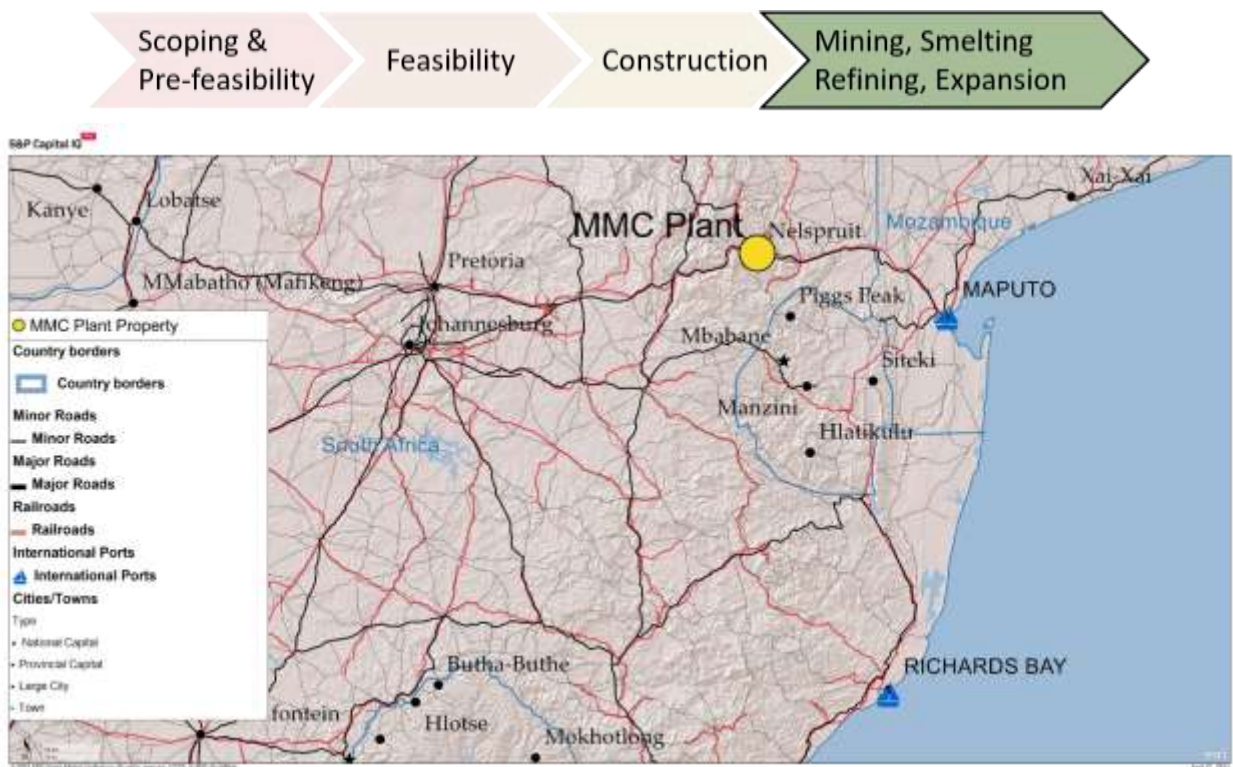


Figure 53. MMC project location, South Africa

### 5.4.2 Economic assessment

#### General project background:

MMC is a producer of high purity manganese metal with more than 50 years of experience. A brownfield plant for high purity manganese sulphate monohydrate (HPMSM) production of 5,000 t/a is planned in the near future. Thereafter, the development of a larger HPMSM plant (~30kt/a) as a greenfield plant on a yet unidentified site in South Africa, probably in a port city, is envisaged. Future plans include developing capacities to produce all types of manganese for different lithium-ion battery applications, including manganese carbonate, manganese oxide ( $\text{Mn}_3\text{O}_4$ ) and manganese phosphate. The HPMSM plant with a 5,000 t capacity is expected to enter production in 2026.

#### Project description:

|                                            |                                                                                                                                    |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Refinery product                           | Currently EMM, future product HPMSM                                                                                                |
| Annual production (capacity)               | 5,000 t HPMSM (phase 1)<br>Planned: 30,000 t HPMSM (phase 2)                                                                       |
| Life of refinery                           | Refinery without own mining complex. Life of refinery depends on the availability of the ore. Long-term contracts are available.   |
| Investment required                        | Ca. € 37.3m (phase 1)                                                                                                              |
| Net present value (NPV)                    | Not available                                                                                                                      |
| Share of global HPMSM production (phase 1) | Ca. 1.25% based on a global production of 128,000 t Mn contained of HPMSM production in 2022                                       |
| Share of global HPMSM production (phase 2) | Ca. 7.5% based on a global production of 128,000 t Mn contained of HPMSM production in 2022                                        |
| Value addition potential                   | Besides HPMSM, there is potential to produce other forms of manganese as oxide, carbonate or phosphate. Currently EMM is produced. |

#### Mining and refining:

- MMC is a refiner and does not own a mining entity. It is using high-grade manganese oxide ore procured from South32's Hotazel Manganese Mines, supplied on a long-term basis. MMC is exclusively using fines and tailings from the mining operation which otherwise would be discarded as waste products. According to South32, their life of mine is until 2064.
- The HPMSM project is part of the upstream value chain of Li-ion battery production. It is a raw materials refining project.
- At present, some of MMC's customers buy its High Purity Electrolytic Manganese Metal (HP EMM) and they dissolve it in sulphuric acid to produce liquid Manganese sulphate, which is then used along with Cobalt- and Nickel sulphates to produce NCM-type Precursor Cathode active material (PCAM) for the Li-ion battery industry.

- MMC's preferred method for producing HPMSM is to use manganese ore instead of HP EMM as starting material. Each orebody requires a 'customised' process / refining route to reach the required purity specification, and MMC has in-house ability to develop such technology. They have successfully developed a highly effective combination of chemical and physical processes to remove impurities from manganese ore and to sustainably produce HPMSM crystals with a low carbon footprint. The company owns three patents accepted for worldwide registration.

#### **BGR assessment and comments:**

- The existing entity has been producing high purity Manganese Metal for more than 50 years. Various certifications and permits, such as environmental permits, export permits, with legal compliance to all appropriate legislation are already in place.
- Several tarred public roads provide access to the MMC project in Mbombela. The site has rail access, with a dedicated siding. As there are frequent disruptions / delays in the rail service, MMC also has the possibility to use road transport to receive inbound raw materials and to dispatch final products to customers or export ports. Main ports used for shipping are Durban and Maputo. Of the current EMM production 95 % is exported.
- MMC plans to export 100% of the HPMSM product. If a battery value chain was established in South Africa, it is envisaged that MMC would supply the required quantity for local consumption and therefore increase local value.
- The cash cost for high-purity manganese production is at least two to three times the cost of material from China, as capital and operating costs outside of China are much higher than in of China. The average price for HPMSM, produced mainly in China, from 2021-2023 was US\$ 1,092.5/t. The challenge will lie in the fact that high performance on ESG implies higher cost of production. It is uncertain if consumers are willing to pay this price to assure the production of "green" materials produced in a comprehensive sustainable manner, outside of China.

#### **5.4.3 ESG assessment**

The existing entity producing high purity Electrolytic Manganese Metal holds various ISO certifications, a wide range of environmental permits, export permits, and legal compliance to all appropriate legislation. Expertise how to operate in a sustainable manner is in place for several decades. MMC is operating a zero-polluting landfill facility but for the HPMSM production, zero landfilling is envisaged, as well as to utilise 100 % renewable energies for the production of HPMSM. Landfilling will be avoided by converting process waste into construction materials. For their manganese metal production, which is dissolved in sulphuric acid to produce manganese sulphate, MMC uses a selenium-free process. Selenium, which is typically used as an additive for Chinese manganese metal production as it reduces the cost of production significantly, is a very

toxic element, both for employee health and the environment. Project information is available from the company on request, limited information on website. No major ESG issues were identified that would preclude responsible investment at MMC.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                             |
| Environmental Management                                           | The existing entity producing high purity manganese metal holds ISO certification ISO 14001:2015 valid until 09/2024. No incidents recorded found.                                                                                                                                                                                                          |
| Efficient use of energy, renewable energy, GHG emissions reporting | Renewable power supply is already on site. The current share of hydro power usage is almost 7 %, 93 % comes from the national grid. However, the project's power requirements will be met 100 % from renewable sources. Monitoring and reporting of scope 1, 2 and 3 GHG emissions monthly.                                                                 |
| Water management and consumption                                   | MMC developed an Integrated Water and Waste Management Plan. A water treatment plan and water use accounts in place. There is also a sump and bund management plan in place as well as a civils and corrosion management plan, including routine inspection and regular maintenance. Water stress level in this region is high; riverine flood risk is low. |
| Pollution prevention                                               | MMC operates an Effluent Treatment Plant (ETP) to treat the liquid effluents from the MMC operations and the leachate from its two RMFs to reduce manganese and ammonium sulphate to comply with discharge standards. MMC operates a selenium-free process (selenium is highly toxic).                                                                      |
| Air quality                                                        | Exposure of workers to manganese dust poses a health risk (Manganism) that needs respective protective and safety measures. Air management plan in place, as well as an air emissions licence, annual external audits, dust measurements protocol and routine employee screening.                                                                           |
| Tailings management                                                | Currently MMC is operating a zero-polluting hazardous landfill facility for the process residue from their metal production. The plan for the new facility (HPMSM) is zero landfilling, which will be possible by residue treatment and conversion into construction material.                                                                              |
| Waste management                                                   | Waste management in place as well as a residue disposal site permit and existing landfill sites. Permit number 16/2/7/X205/B26/Y2/P482 under section 20(1) of the Environment Conservation Act, 1989 (Act 73 of 1989) (ECA). Waste from HPMSM plant will be beneficiated for use as bricks and in cement.                                                   |
| Hazardous materials management                                     | See "Pollution prevention".                                                                                                                                                                                                                                                                                                                                 |
| Noise and vibration                                                | The plant is located in Mbombela, a city with more than 110,000 inhabitants. As an OHS management plan is already in place for the current EMM plant, it is considered that the impacts for the new plant can be addressed accordingly.                                                                                                                     |
| Protected areas and biodiversity                                   | The project is not located in or close to a key biodiversity area. Expected biodiversity impacts are low. The refinery is already in place for more than 50 years. However, an incident of overflow might affect the nearby tributary of the Crocodile River, which flows into the Kruger National Park. Storm                                              |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | water draining and collection system in place to manage spillages and storm water.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Mine Closure                                              | Not applicable as the project is not a mine. However, MMC does have a provision for environmental rehabilitation in case of closure of the refinery.                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Community health, safety and security                     | The plant is located in Mbombela, a city with around 110,000 inhabitants. The impact on the community will not change with the start of HPMSM production. Hence, potential negative impacts for the new plant on local communities are considered low risk.                                                                                                                                                                                                                                                                                                  |
| Dialogue and engagement with communities and stakeholders | Stakeholder management plan in place. Public members can submit complaints at the office. Quarterly meetings with neighbouring communities in the vicinity; no reports on conflicts.                                                                                                                                                                                                                                                                                                                                                                         |
| Land acquisition and involuntary resettlement             | Not applicable, as the refinery is already in place for more than 50 years.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Occupational health & safety management                   | OHS management plan included in the management plan. The ISO integrated system audit covers the HSEQ plan in full detail. Emergency response plan, dedicated safety and fire officials and a doctor and nurses on site. ISO 45001:2018 certification.                                                                                                                                                                                                                                                                                                        |
| Workers' rights                                           | South Africa scores 79/100 in the Labour Rights Index, means reasonable access to decent work. Workplace management plan in place, with various policies to monitor and eliminate discrimination and ensure equity at all levels of organization.                                                                                                                                                                                                                                                                                                            |
| Gender and diversity                                      | Non-discrimination policy in place; Corporate Social Investment plan in place, e.g. MMC will continue to employ females in traditionally male dominated positions, and employment targets are set in accordance with provincial demography.                                                                                                                                                                                                                                                                                                                  |
| Local value added and community development               | Automation and intelligent process control systems might mean a lower number of employees per production output compared to the existing process, which is not heavily automated. Regardless, MMC states that it will continue to include employees and the local community, continue to train and develop staff, and continue the ethical approach to all matters related to employees and the local community. Core competence in chemistry and management has to be present in the local community and MMC's training program aligns with this objective. |
| <b>Governance</b>                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Legal compliance                                          | According to the company comprehensive and structured information on ESG-related policies and management are in place, as are various ISO certifications, a wide range of environmental and export permits, with legal compliance to all appropriate legislation. No indication of any law breaches found.                                                                                                                                                                                                                                                   |
| Management practices                                      | MMC commenced a process to formalise their ESG objectives and targets. Limited (one pager) ESG information on policies available on website                                                                                                                                                                                                                                                                                                                                                                                                                  |



| ESG category               | Assessment                                                                                                                                                                                                                                                                                                   |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | (Health, safety, environment & quality policy; energy policy), regular external and internal audits conducted, Occupational Health & Safety Management System certified against ISO 45001:2018.                                                                                                              |
| Transparency and reporting | MMC is a company that operates privately and has not offered any shares to the public. The company is not listed at any stock exchange. Financial reports are not publicly accessible and must be requested from the company directly. Annual audits of financial statements and tax compliance takes place. |
| Business ethics            | South Africa scores 41/100 in the Corruption Perception Index; South Africa is not an EITI country; no indication of unethical company practices found; Ethics policy in place which covers the Business Integrity Plan. Ethics committee meet on a quarterly basis and reports to the board directly.       |

**Table 73. ESG features of the MMC plant, South Africa**

#### 5.4.4 Further reading

MMC (2023): Public presentation on the HPMSM market, delivered by MMC during the Fastmarkets European Battery Raw Materials Conference, in Amsterdam, Netherlands, on 19 September 2023.

MMC (2024): Manganese Metals Company Homepage; <https://www.mmc.co.za/> [Last visit 20.02.2024].

## 5.5 Mopani sediment-hosted Cu (-Co) project (Zambia)

Information as of 01/2024

### 5.5.1 General project background

|                                 |                                                                                                                                                                                                          |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Copper                                                                                                                                                                                                   |
| <b>Other commodities</b>        | Cobalt                                                                                                                                                                                                   |
| <b>Location</b>                 | Copperbelt, Zambia<br>12°32' S, 28°14' E, 1,200 – 1,300 m.a.s.l.                                                                                                                                         |
| <b>License type</b>             | Large-scale mining and processing licenses: Mufulira, and Nkana                                                                                                                                          |
| <b>License owner / operator</b> | Mopani Copper Mines Plc. (51 % International Resources Holding (IRD), 49 % Zambia Consolidated Copper Mines –International Holding (ZCCM-IH) Plc. (Zambia gov.))                                         |
| <b>Contact</b>                  | Nkana West, Corner of Central Street, 5th Avenue<br>Kitwe, Copperbelt, Zambia<br><a href="https://mopani.com.zm/public.relations@mopani.com.zm">https://mopani.com.zm/public.relations@mopani.com.zm</a> |
| <b>Project status</b>           | Production - Expansion                                                                                                                                                                                   |
| <b>Production by 2030</b>       | Yes; announced ramp-up to 200 ktpa copper by 2027                                                                                                                                                        |

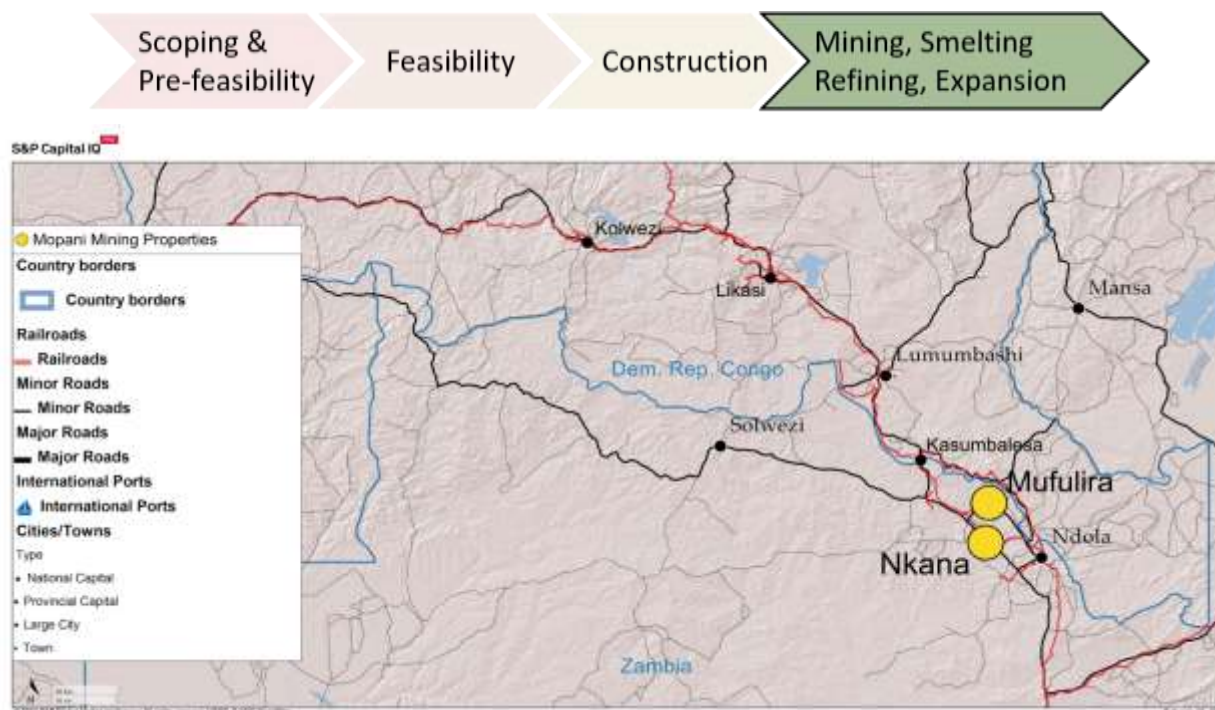


Figure 54. Mopani project location, Zambia

### 5.5.2 Economic assessment

#### General project background:

Mopani's mines in Kitwe (Nkana) and Mufulira (50 km north of Kitwe) were discovered in the 1920s and have been mined since the 1930s. The project currently comprises underground mines, concentrators, a smelter and a refinery. The Nkana orebodies occur within the north-westerly plunging Nkana synclinorium located on the south-western flank of the Kafue anticline. Copper and cobalt occur within the ore shales (Lower Roan group), within the southern and central areas. They can be structurally complex, but are largely planar, shallow to steeply dipping, especially in the northern Mindola mining areas. Copper mineralisation changes from mostly chalcopyrite in the South shaft area, to chalcopyrite-bornite in the Central shaft area and to bornite-chalcopyrite at the Mindola shafts. At Mufulira, meta-sandstones host the mineralisation in three uniform ore horizons within the Lower Roan group. The primary sulphides at Mufulira are bornite and chalcopyrite. Oxide caps (malachite and minor azurite) occur at the eastern and western limits of the deposit and are mined via portals and declines underground. Mopani assets require investment for infrastructure upgrades and modernisation of mining and processing equipment to increase production (to 200,000 t/a within the next 3 years), improve efficiencies and extend the life of mine. The new infrastructure includes three deep shafts, namely the Synclinorium, Henderson and Mindola Deeps shafts, whose construction is not yet complete.

#### Project description:

|                                    |                                                                                                        |
|------------------------------------|--------------------------------------------------------------------------------------------------------|
| Ore deposit type                   | Stratiform, sediment-hosted copper deposit                                                             |
| JORC compliant Reserves            | 93 Mt @ 1.92 % Cu, 0.067 % Co (2022)                                                                   |
| Share of global copper reserves    | 0.2 % ( <i>USGS estimate global Cu reserves of 890 Mt</i> )                                            |
| Share of global cobalt reserves    | 0.8 % ( <i>USGS estimate global Co reserves of 8.3 Mt</i> )                                            |
| JORC compliant resources           | 233 Mt @ 2.16 % Cu, 0.084 % Co (2022)                                                                  |
| Share of global copper resources   | 0.2 % ( <i>USGS estimate global Cu resources of 2100 Mt</i> )                                          |
| Share of global cobalt resources   | 0.8 % ( <i>USGS estimate global Co resources of 25 Mt</i> )                                            |
| Waste to ore ratio (whole orebody) | Low, referred to underground mining methods                                                            |
| Annual production                  | Pre-expansion: 73 kt of saleable Cu (in 2022), 2,400 t of Co<br>Post-expansion: 200 kt of saleable Cu  |
| Life of mine                       | Post-expansion: >25 years                                                                              |
| Investment required                | US\$ 1.5bn (referring to Glencore's expansion CAPEX in 2012)                                           |
| Net present value (NPV)            | Not defined                                                                                            |
| Share of global copper production  | 0.9 % (200 kt of Cu/a, recovery >90 %)<br>( <i>USGS estimate global Cu production of 22 Mt</i> )       |
| Share of global cobalt production  | 1.3 % (2,400 t of Co/a, recovery not known)<br>( <i>USGS estimate global Co production of 190 kt</i> ) |

#### Mining and processing:

- Nkana is located 290 km north of Lusaka and ~5 km southwest of Kitwe - Mufulira ~50 km north of Kitwe, which is connected to the main national highway (T3) between Lusaka and the

DR Congo. Power is supplied via the national grid (Copperbelt Energy Corporation Plc.). Underground mining is employed using longitudinal room and pillar, sub-level caving, sub-level open stoping, longitudinal stoping and vertical crater retreat. Three new shafts shall replace the old infrastructure. The Synclinorium and Henderson (1,547 m deep) shafts at Mufulira have already been sunk and equipped, but are not yet operational. The shafts will have ore and waste hoisting capacities of 4 Mt/a and 3 Mt/a, respectively. The Mindola Deeps shaft sinking at Nkana has not yet been completed, but once realised it will reach 2,020 m.

- The company operates three concentrators (two at Nkana and one at Mufulira). The new Nkana Synclinorium concentrator in Kitwe was commissioned in 03/2022 and is expected to improve recoveries (>95 %) and improve production efficiencies for the concentrates (copper grade 23-25 %) while the old Nkana concentrator has since been placed under care and maintenance. The Mufulira concentrator achieves recoveries >94 % and copper grades of ~40 %. The ore is concentrated via crushing, milling and sulphide flotation. All concentrates are blended and fed into the smelter at the Mufulira mine site (720,000 t/a concentrate feeding capacity) to produce copper anodes (copper grade 99.6 %). Copper anodes are then electro-refined at the company's refinery which has the capacity to produce 220,000 t/a of copper cathode (copper grade 99.999 %). The company owns three solvent extraction-electrowinning plants and one vat-leach plant to recover copper from company-mined or purchased oxide ores from local miners. The all-in costs (including development and expansion CAPEX) in 2022 were given at US\$ 4.68/kg of copper for Mufulira and US\$ 3.33/kg of copper for Nkana. This compares with a realised copper sales price of US\$ 8.79/kg until 31 December 2022.
- After disagreements with Glencore, ZCCM-IH acquired 90 % of Glencore's interest in Mopani in 03/2021. Glencore continues to retain offtake rights for Mopani's production. In 12/2023, following a public tender process, ZCCM-IH entered into an agreement with the Emirati International Resources Holding, which has committed to invest a total of US\$ 1.1bn into Mopani Copper Mines as a strategic equity partner in return for a 51 % stake.

#### **BGR assessment and comments:**

- The Mufulira and Nkana deposits are relatively high-grade, high-tonnage underground operations. The long life of mine (>25 years) can be positive for regional development. Further resource expansions are possible due to ongoing exploration and the stratiform geometry of the orebody, which extends over a very long distance underground.
- Mopani Copper Mines expects infrastructure upgrades to reduce production costs by a significant US\$ 3.75/kg of copper. The profitability of the planned cobalt production depends on how complex the ore is and how the processing has to be designed (e.g. roasting, leaching).

### 5.5.3 ESG assessment

Due to the changing ownership in the past, from state-owned to Glencore/Vedanta back to state-owned and now to International Resources Holding, it might be difficult to verify the current owner's responsibilities with regard to historic legacies and liabilities. This is especially relevant for older tailings, closure costs and legacy environmental issues related to smelting, refining and pollution of streams, among others.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Environmental management                                           | Operator's Environmental Management System complies with ISO 14001: 2015 for the production and supply of electrolytically refined copper cathodes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Efficient use of energy, renewable energy, GHG emissions reporting | There is no information on GHG emissions. Zambia's national grid is mainly hydropower, nevertheless there will be diesel consumption of the mining and ore transportation fleet and additional GHG emissions from smelting.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Water management and consumption                                   | The Copperbelt is a region with low water stress. Water consumption not reported. An important issue for most mines in the Copperbelt is water quality, which is often very negatively influenced by mining operations, especially legacies from the almost 100 years of mining history (waste dumps, tailings, smelters and refineries). Mopani Copper Mines (MCM) provides water and sanitation services in Kitwe and Mufulira.                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Pollution prevention                                               | The ore, low grade waste rock and tailings usually contain sulphides, with significant potential for acid mine drainage. There are frequent reports about water and air pollution in the region.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Air quality                                                        | Since the processing, smelting and refining operations are directly located in the cities of Mufulira and Kitwe, with almost 1 million inhabitants in the region, the company has to pay attention to emissions released from its processing, smelting and refining plants. As the mines themselves are underground operations, no harmful releases from mining are expected, except for contaminated water from mine dewatering. The smelter is equipped with a sulphuric acid plant, capturing around 97 % of the produced SO <sub>2</sub> during smelting. Nevertheless, people from surrounding neighbourhoods do complain about respiratory problems, related to the release of acid mist, rather than SO <sub>2</sub> , as before. Dust emissions from the processing facility and the TSF have to be mitigated as the amount of fines in the TSF is high. |
| Tailings management                                                | Tailings management is of particular importance, as there is a strong rainy season in the Copperbelt. TSF might have to release water in the wet season and also during the dry season, when water levels are lower. This could negatively influence water quality. For the expansion, MCM is in the process of reinforcing and expanding its TSFs in Kitwe and Mufulira to handle the expected significant increase in the volume of tailings from the additional production at the new expansion projects and to prevent potential dam failure. Feasibility studies that incorporated geotechnical factors, design, emergency response plans were prepared/reviewed by                                                                                                                                                                                         |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | third parties. Upgrade of services installations that include real time monitoring of dam infrastructure were announced to be completed by 2022. Construction of the dam walls was announced to be commenced in 2022 and to run concurrently with the completion of the expansion projects. There are several legacy TSFs and slag dumps, with partly unknown ownership.                                                                                                                                                                                                                                                                                                                                             |
| Waste management                                          | Low amount of waste rock expected due to underground operation. No further information available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Hazardous materials management                            | Bleed stream leaching operations and refining process unknown. Handling of sulphuric acid and other materials unknown. No information available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Noise and vibration                                       | No information available, but would be critical, as mine located in direct vicinities of Kitwe (>500,000) and Mufulira (>150,000 inhabitants).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Protected areas and biodiversity                          | Not located in or close to any key biodiversity or designated protected area.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Mine closure                                              |  <p>Latest available information about closure costs and obligations by Glencore in 2011 (<a href="https://www.miningdataonline.com/reports/Mopani-May-2011-TR.pdf">https://www.miningdataonline.com/reports/Mopani-May-2011-TR.pdf</a>). Costs were given at US\$ 51.6m at that time. Certain areas are excluded by ZCCM-IH (p. 121 of 2011 report). Several risk areas like TSFs can be identified, as a safe cover is difficult due to seasonal rainfall. Discharged water should be treated to achieve pH over 8.5 to prevent acid and metal containing drainage, but post closure treatment is only budgeted for 3 years.</p> |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Community health, safety and security                     | Several reports about health concerns of neighbourhoods close to the smelter and refineries, mostly related to off-gas releases. MCM provides healthcare services, like hospitals, community health programmes and several community clinics, and a community sensitisation and curative healthcare programme.                                                                                                                                                                                                                                                                                                                                                                                                       |
| Dialogue and engagement with communities and stakeholders | No information on structured dialogue with communities available, but several information about measures for local population. The company established a confidential whistleblowing line for community complaints and as grievance mechanism. The company has set up capacity building initiatives to develop local communities and micro, small and medium enterprises. MCM claims to focus on a supplier development programme, women in mining programme and community investment projects.                                                                                                                                                                                                                      |
| Land acquisition and involuntary resettlement             | Reports about forced expulsion in 2010, related to then-owner Glenore. In general, the area size for the expansion project is relatively small as it is an underground operation and the processing, smelting and refining plants are already in place. Nevertheless, the TSF will require additional land.                                                                                                                                                                                                                                                                                                                                                                                                          |
| Occupational health & safety management                   | MCM is ISO 45001: 2018 certified for Mining and Refining of copper and cobalt.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Workers' rights                                           | Zambia scores 66.5 out of 100 in the Labour Rights Index, comparable to surrounding countries. Nevertheless, 66.5 out of 100 refers to the category of "limited access to decent work". No recent information on the issue.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |



| ESG category                                | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gender and diversity                        | MCM supports women in their supplier business through their Mopani Women in Mining Forum & Exhibition 2024 (as well as 2023) to facilitate and strengthen companies led by women or with women as majority shareholders to gain increased access to Mopani's supply and value.                                                                                                                                                                                                                                                         |
| Local value added and community development | MCM runs several CSR measures and follows a local content policy. According to the 2022 EITI report, they paid around US\$ 52m to the Zambian government in 2022 (3 % of all mining fiscal revenues). The company runs two primary and two secondary schools in Kitwe and Mufulira, as well as a Mining and Engineering skills training centre in Mufulira. The Mopani Central Training Centre in Mufulira trains mining industry-oriented graduates and is a technical education, vocational and entrepreneurship training authority. |
| <b>Governance</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Legal compliance                            | No information, but assumed to be compliant, as major share belongs to state-owned company.                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Management practices                        | Quality Management System certified (ISO 9001: 2015) for underground engineering workshops, refining and supply of electrolytically refined copper. Further certificates are ISO 14001:2015 Environmental Management System related to cathode material (not mining) and ISO 45001: 2018 Occupational Health and Safety (mining and refining). General statements on vision related to ESG aspects.                                                                                                                                    |
| Transparency and reporting                  | MCM reports figures to the Zambian EITI secretariat. No sustainability reporting or other ESG reporting available on company website. IRH has its headquarter in Abu Dhabi and is not listed on a stock exchange. IRH is part of an Abu Dhabi conglomerate (IHC) which is, according to Reuters news agency, led by a key member of the United Arab Emirates' ruling family.                                                                                                                                                           |
| Business ethics                             | Zambia is not classified as CAHRA (conflict affected and high-risk area; EU); the country scores 37 out of 100 in the Corruption Perceptions Index (rank 98 of 180). IRH has very limited information on company structure and management on its website; no indication of unethical practices found.                                                                                                                                                                                                                                  |

Table 74. ESG features of Mopani project, Zambia

#### 5.5.4 Further reading

Mining Data Online (2023): Mopani Operation (Mufulira Mine, Nkana Mine).

<https://miningdataonline.com/property/1256/Mopani-Operation.aspx> (accessed: 05.01.2024)

Miningmx (2023): Sibanye-Stillwater saddles up with Chinese in bid for Mopani Copper.

<https://www.miningmx.com/news/base-metals/54316-sibanye-stillwater-saddles-up-with-chinese-in-bid-for-mopani-copper/> (accessed: 04.01.2024)

ZCCM Investment Holdings Plc. (2023): Transaction announcement regarding Mopani Copper Mines Plc 22.12.2023. <https://www.actusnews.com/en/zccm/pr/2023/12/22/zccm-ih-transaction-announcement-regarding-mopani-copper-mines> (accessed: 04.01.2024)

## 5.6 Special economic zone on battery value chains (DR Congo)

Information as of 03/2024

### 5.6.1 General project background

|                                        |                                                                                                                                                                                                         |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Target commodities</b>              | Refining of cobalt & lithium (battery-grade chemicals)<br>Purchase (optional refining) of other battery metals<br>Production of (precursor) cathode active material                                     |
| <b>Location</b>                        | Kolwezi, DR Congo (and partner zone in Zambia)<br>10°45' S, 25°35' E, 1,340 m.a.s.l.                                                                                                                    |
| <b>License type</b>                    | Specially licensed industrial area                                                                                                                                                                      |
| <b>License owner / operator</b>        | To be established                                                                                                                                                                                       |
| <b>Contact</b>                         | Conseil Congolais de la Batterie (CCB)<br>Ecobank Building, 2 Av. Kasavubu, Kinshasa-Gombe<br><a href="https://www.ccb.cd">https://www.ccb.cd</a><br><a href="mailto:contact@ccb.cd">contact@ccb.cd</a> |
| <b>Direct contact established: Yes</b> |                                                                                                                                                                                                         |
| <b>Investors targeted</b>              | (1) Construction of Special Economic Zone (SEZ)<br>(2) Phased approach for setting up of associated metal refiners & plants in the lithium-ion battery value chain                                      |
| <b>Production by 2030</b>              | Technically possible, but currently uncertain. Reduced scale (e.g., focus on cobalt refining) more realistic.                                                                                           |

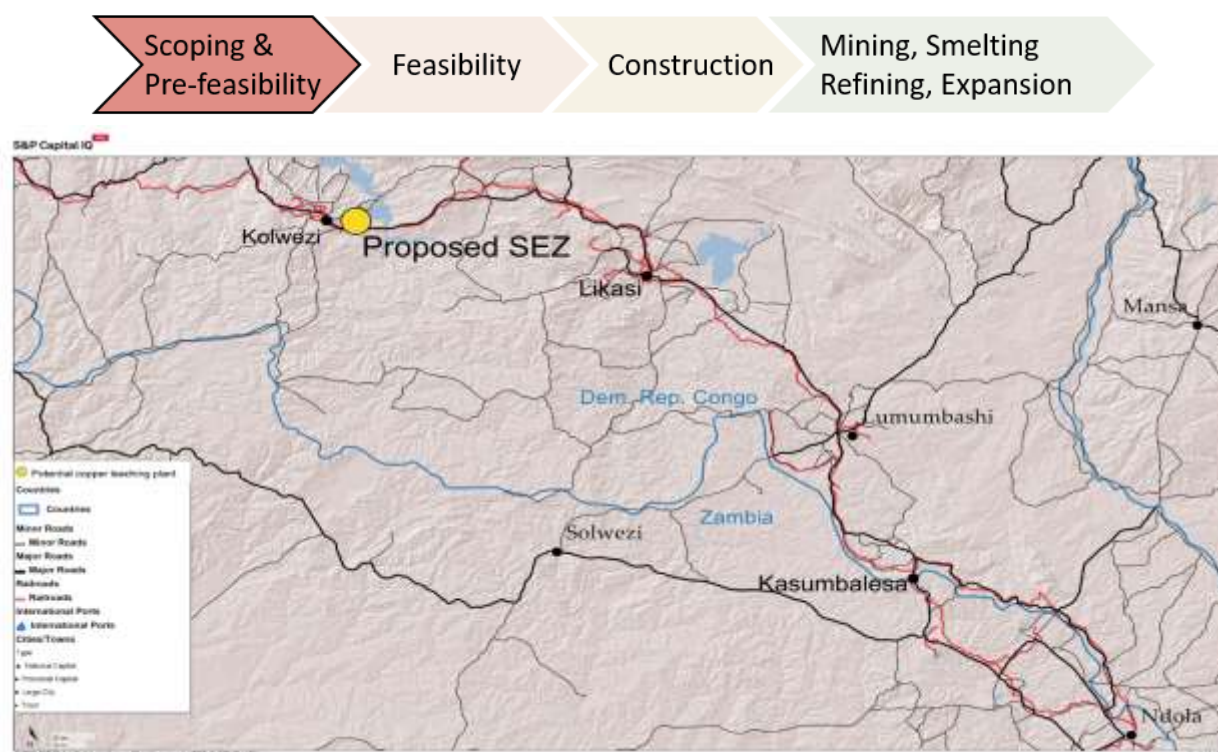


Figure 55. Location of Special Economic Zone for Batteries, DR Congo

### 5.6.2 Economic assessment

#### General project background:

The Special Economic Zone (SEZ) on battery value chains in the DR Congo seeks investment on two levels: (1) infrastructure and general development of the SEZ, and (2) individual facilities for refining battery metals and manufacturing plants in the associated downstream battery value chain, within the SEZ. A partner SEZ shall be developed in Zambia. The economic argument for the SEZ circles around the presence of cobalt and lithium deposits in the DR Congo, and nickel and manganese deposits in Zambia – the basic ingredients for NMC (nickel-manganese-cobalt) lithium-ion battery (LIB) cathodes. Building chemical refining and further processing facilities in the region would allow capturing a higher value share locally while reducing LIB life cycle carbon emissions due to the Congolese power grid's low emission intensity and minimised transport distance for trucking ore concentrates or unrefined products. Even though local energy costs might be higher than in China or other African countries, their impact on overall operational expenditure would be outweighed by the reduced transport costs and lower wages associated with in-region manufacturing.

The governments of the DR Congo and Zambia cooperate with a range of partners to develop the SEZ concept. This includes a framework agreement with the African Export-Import Bank and the UN Economic Commission for Africa who, along with additional partners, facilitated a concept study by BloombergNEF (2021) as well as a pre-feasibility study by ARISE Industrial Integrated Platform (ARISE IIP 2023). In parallel, a Centre of Excellence for Advanced Battery Research to address SEZ-related skill development was established by the University of Lubumbashi and universities in Zambia, partnering with the German Steinbeis Global Institute as well as the Swedish LIB manufacturer Northvolt. Furthermore, in 2023, the United States signed an MOU with the DR Congo and Zambia to support battery value chain development and help attracting US investors. The CCB, a national multi-stakeholder initiative in the DR Congo, acts as an advising body and contributes to the SEZ planning process, in coordination with several ministries and public services.

The general SEZ development was recently evaluated at the pre-feasibility level by ARISE IIP. Additional feasibility studies on the construction of individual plant facilities will be necessary to populate the SEZ with business operators in the battery value chain. The general SEZ concept proposes a phased approach which, on the Congolese side, initially focuses on the SEZ hosting hydrometallurgical refining facilities to produce battery-grade lithium and cobalt chemicals as well as a plant for (precursor) cathode active material ((P)CAM) which may be shipped to international markets. Further downstream manufacturing facilities, down to full battery pack assembly, might be added progressively at a later stage, particularly with a view to supplying the growing African electric vehicle market. Operationalising the Congolese SEZ will require cross-border cooperation with the Zambian SEZ for the supply of nickel and manganese sulphate.

Significant tonnages of graphite for anode active material manufacturing would have to be imported from third countries, similar to other metals and battery chemicals, except for copper, which is recovered locally in the DR Congo and Zambia.

The following table presents battery metal input estimates for the two SEZ in the DR Congo and Zambia combined, modelled to supply 35 GWh of NMC 811 type cathodes as target capacity for 2040 (ARISE IIP 2023). This value was selected by ARISE IIP in relation to an estimated LIB market size of 50 GWh in Africa and assuming a 70% market share of NMC 811 cathodes in 2040. The other 30% (15 GWh) are attributed to LFP (lithium iron phosphate) type cathodes, which might potentially be manufactured in the SEZ at a later stage, after operationalising NMC 811 cathode production.

### Project model parameters:

#### Throughput of refined battery chemical products (DR Congo and Zambia SEZ combined)

|                                                                                                           |                                      |
|-----------------------------------------------------------------------------------------------------------|--------------------------------------|
| Lithium hydroxide & carbonate                                                                             | 22,000 & 1,000 tpa (DR Congo supply) |
| <i>Li carbonate foreseen for electrolyte manufacturing; electrolyte could also be imported as product</i> |                                      |
| Cobalt sulphate                                                                                           | 15,000 tpa (DR Congo supply)         |
| Manganese sulphate                                                                                        | 9,000 tpa (Zambia supply)            |
| Nickel sulphate                                                                                           | 109,000 tpa (Zambia supply)          |
| Graphite                                                                                                  | 37,000 tpa (external supply)         |

#### Investment scale (DR Congo only)

|                                              |                                                                                     |
|----------------------------------------------|-------------------------------------------------------------------------------------|
| SEZ & infrastructure development (2024-2026) | ~US\$ 200m (including development costs, contingencies, marketing, financing costs) |
| Cobalt sulphate plant (2025-2027)            | US\$ 20-30m (see assessment comment below)                                          |
| Lithium hydroxide plant (2025-2028)          | ~US\$ 250m                                                                          |
| (P)CAM plant (NMC cathodes) (2025-2027)      | ~US\$ 260m                                                                          |

### BGR assessment and comments:

- While the DR Congo already hosts several crude cobalt hydroxide production facilities, the task of producing refined high-purity chemical products such as cobalt sulphate would introduce additional complexity. This applies especially for the highly sophisticated process of manufacturing (P)CAM. It will therefore be critical for the SEZ to attract international investors with appropriate operational experience and/or partners to license their processing technology.
- The projected annual cobalt use in NMC battery cathodes to be produced in the SEZ, about 3,000 t of cobalt content contained in 15,000 t of cobalt sulphate, is only a small fraction of the DR Congo's national cobalt output (currently around 150,000 tpa). This implies a relatively high chance to secure cobalt supply, especially if local supply was encouraged through fiscal incentives, though it might raise the question whether in-country cobalt sulphate production

would be economic at this scale, or whether a new facility could additionally produce cobalt sulphate for export (beyond the Zambian SEZ) to benefit from economies of scale. The CAPEX estimate for the cobalt sulphate plant appears to be relatively low and depends on the selected process technology (e.g., hydroxide leaching vs. direct solvent extraction). It will be important to evaluate this in a feasibility study.

- The overall business case for a battery-related SEZ in the DR Congo hinges on cobalt forming part of the battery cathode. The SEZ proponents propose NMC 811 type cathodes as production target. This cathode type is relatively low in cobalt, which is positive for product pricing, and is expected to have a significant market share in the EV sector in the near to medium term. If the SEZ became fully operational in 2028 and supplied 35 GWh worth of batteries with NMC cathodes to global customers, this would represent 6% of the projected global NMC demand of that year. Hence, this market scenario appears reasonable.
- The business case for manufacturing LFP type cathodes in the SEZ, in addition to NMC cathodes, is less clear-cut. Other countries, Morocco in particular, may be in a more advantageous position to leverage this cathode type for local value addition, given their raw material endowment and logistical situation. In fact, Morocco is already securing investment in both LFP and NMC type battery plants. Beyond raw material endowment and favourable logistics, the country has a fiscal advantage in terms of accessing the European and US markets (EU-Morocco Association Agreement; US Morocco Free Trade Agreement). As such, it would be important to clarify whether Morocco, or indeed other African countries, would be a strategic partner or potential competitor for the SEZ, since there may be an overall limit (saturation level) for the investment and market potential in Africa's battery value chain.
- The DR Congo currently does not recover any lithium from mining, except perhaps small amounts of spodumene concentrate handpicked by artisanal miners. The expected main lithium supplier for the SEZ is the Manono project. A feasibility study for Manono was completed in 2020 (AVZ 2020) and, in January 2024, resources were increased to 842 Mt @ 1.6% Li<sub>2</sub>O, making it the largest undeveloped lithium hard rock deposit in the world. However, Manono is currently the subject of a legal dispute, which is ultimately a dispute about the control of the concession between AVZ (Australia) and Zijin Mining (China). This dispute has the potential to delay project development. Previously, in 2020, AVZ signed an MOU with the Congolese government to establish the "Manono Special Economic Zone" in Tanganyika Province, which would hence have to be integrated with the Kolwezi-based SEZ concept presented above.
- Given the importance of lithium for the overall SEZ business case, it might be useful to reflect on near-term lithium supply alternatives in case Manono development is delayed. For instance, value chain cooperation or vertical integration opportunities might be explored with lithium project developers in Zimbabwe or Namibia. The joint venture by Pilbara Minerals (the



operator of a lithium mine in Australia) and POSCO to jointly proceed with lithium hydroxide refining in South Korea might serve as an example in this regard.

### 5.6.3 ESG assessment

The SEZ concept is supported by two main ESG arguments: (1) it increases local value addition and employment, and (2) it reduces carbon emissions in the LIB supply chain. Both arguments are plausible. The value generated from (P)CAM manufacturing typically exceeds the value of the contained metal by a factor of 20-25 whereas cobalt exported from the DR Congo as crude cobalt hydroxide only generates 60-80% of the contained metal value, depending on the market situation. In their prefeasibility study, ARISE IIP (2023) estimate that 25,000 direct and 62,500 indirect jobs could be created in the DR Congo if the SEZ was operationalised in full.

For their carbon emission scenario analysis for a local (P)CAM plant, BloombergNEF (2021) modelled a supply chain where battery packs are manufactured in Germany, CAM and battery cell manufacturing takes place in Poland and (P)CAM (NCM 811) is imported from the DR Congo. This supply chain structure results in battery life cycle emissions of 59 kg CO<sub>2</sub>/kWh, compared to 72 kg CO<sub>2</sub>/kWh if the PCAM was imported from China instead. Achieving reductions in the battery life cycle carbon footprint would be in line with the policy objectives pursued by the European Green Deal (2020) and the EU battery regulation (2023). Overall, the main factor influencing in-region carbon emissions is the low emission intensity of the Congolese power grid, which reflects its high share of hydropower. There is a challenge to ensure sufficient availability of power, though, and much of the DR Congo's hydropower potential remains unexploited to date. In addition to the local grid impact, a shorter supply chain with minimised transport distance of products towards international downstream customers would contribute to the lower emission profile of SEZ-manufactured LIBs as well, especially if the SEZ could make full use of the Lobito railway line, which is currently being upgraded. From a downstream market perspective, streamlined logistics might additionally increase supply chain resilience.

Notwithstanding these positive aspects, several potential ESG challenges should be considered when progressing with SEZ development. For once, the SEZ in the DR Congo, as in other countries, would be subject to new regulations specially drafted for the SEZ to attract investors and expedite business development. This may offer an opportunity to pass regulations, which include state-of-the-art ESG requirements and support international regulatory alignment. However, it might also imply risks, especially with regard to employment conditions and labour rights that have been criticised in certain SEZs elsewhere.

At a technical level, metal refining and (P)CAM manufacturing plants typically require high amounts of water for washing and filtration processes. This underlines the importance of water risk management and water recycling at the SEZ, with particular emphasis on its site-specific water balance as well as adequate effluent treatment. As part of an EIA and a water balance, it



might be relevant to evaluate and prevent potential conflicts on water use. This further raises the question whether Congolese environmental authorities are properly staffed and equipped to monitor water and other ESG risks in relation to the SEZ. It might therefore make sense to integrate the question of capacity building for governmental monitoring bodies in the overall concept for SEZ skills development.

### 5.6.4 Infrastructure assessment

The following general infrastructure assessment was performed based on the assumption that the SEZ would be installed in or close to Lubumbashi, as originally planned. With the current scenario to host the SEZ in Kolwezi instead (as shown above), most observations below would no longer apply directly. However, they are shown anyway, since there may not yet be a final decision for the SEZ location and, irrespective of the SEZ, these infrastructure observations might also be applied to other Lubumbashi-based potential investment ideas.

#### Potential Investment Needs:

- **Road Infrastructure:** Upgrade of road infrastructure between SEZ location(s), respective mining projects, and local rail networks. Approximately US\$ 38,000 per km to resurface with an asphalt overlay < 40 mm, and US\$ 70,000 per km to reseal with an asphalt overlay 40-59 mm (two-lane road).
- **Railway Enhancements:** Railway maintenance, repair, and expansion (especially in the DRC) to provide efficient transport solutions from ERCM project sites to SEZ development areas. Extend/modernise railway in the DRC (continuation of North-South Rail Corridor) – additional investment potential. Railway construction and rehabilitation costs in the region are estimated at US\$ 1.98m per km and US\$ 1.28m per km, respectively.
- **Renewable Energy Ventures:** Harness hydro energy potential in strategically significant location.
- **Port Storage Facilities:** Investment potential to upgrade port capacities and/or port accessibility to fully capitalise on the export potential of the battery electric vehicle market.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | Afreximbank and the United Nations Economic Commission for Africa (ECA) signed a Framework Agreement on the 11.04.23 towards establishing the SEZ for the production of Battery Electric Vehicles (BEVs) and related services in DRC and Zambia. The project will deploy well-established and proven BEV technology that will enable both countries to exploit their mineral resources at scale. In doing so, DRC and Zambia are in a unique position to shift from exporters of raw materials to becoming regional and global manufacturers and suppliers of the battery precursors. The following assessment assumes that the city of Lubumbashi in DRC plays an important geographic role in the SEZ project framework.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Transport                 | Road infrastructure (highways and national roads) surrounding Lubumbashi is scarce and fractured. Trunk roads (highways) are commonly sealed, whereas primary roads (national highways) consist of varying sealed and unsealed segments. The N1 highway is the lifeline of Lubumbashi, being the only sealed road of the city. To the south the N1 merges with Zambia's T3 highway at the border, providing access to the nearby T5 highway to the west and later merging into the T2 highway (Great North Road) providing access to the Tanzanian border in the north and the Zimbabwean border in the south via Lusaka. Investment potential includes upgrading, repairing, and expanding sealed road infrastructure from ECRM project sites to SEZs and from SEZs to rail networks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Airport                   | Luano International Airport in Lubumbashi and Solwezi Airport in Zambia are expected to play pivotal roles in the development of the SEZs. Lubumbashi and Solwezi airports exhibit a single 3.15 km and 2.7 km asphalt runway, respectively. Lubumbashi airport predominantly serves mining activities in the region, while Solwezi is primarily used for private and chartered flights. Investment opportunities to increase airport handling and storage capacities for the development of the SEZ project area(s).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Rail access               | Rail infrastructure connects the two countries with the ports of Lobito in Angola, Dar es Salaam in Tanzania, Beira in Mozambique, as well as Durban in South Africa. This infrastructure, however, is partially fragmented, with segments of railway in dire need of maintenance, repair, or replacement. The currently operating rail network serves mining activities in the Copperbelt region and shows great potential to supplement the development of SEZs in both countries. Nevertheless, due to inefficiencies in management and administration, the rail system performs largely below its designed threshold capacity. There is currently strong financial backing in the "Lobito Corridor" project, connecting Zambia and the DRC with existing rail infrastructure in Angola. This project aims to support the extraction of ECRMs, while ensuring a strategically advantageous export location on the Atlantic coast. A memorandum of understanding has been signed by Angola, DRC, Zambia, the US, and the European Commission. Furthermore, the Chipata – TAZARA (Tanzania-Zambia-Railway) railway link has been approved and funded, providing rail access to Malawi and consequently the Nacala port (Mozambique) via the Nacala Railway Corridor. Construction costs for single Cape-gauge tracks in the region are estimated at US\$ 1.98 million per km. Rehabilitation costs in the region may be comparable with the Luanda-Malanje project in Angola, which was estimated to cost US\$1.28 million per km. |
| Port                      | The land-locked nations in around DRC currently have access to ports in Angola, Tanzania, Mozambique, and South Africa via rail. Current rail developments will link the SEZs with additional ports (e.g., Nacala, Mozambique). However, to fully capitalise on the export potential of the Battery Electric Vehicles (BEVs) market, ensuring port access and handling                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | capacity is essential. Feasibility study is currently underway - scale of project yet to be defined. Investment potential to upgrade port capacities (TEU/bulk handling and storage) and/or port accessibility.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Energy       | Energy infrastructure (power plants and transmission lines) is established in both nations. The Zambian Copperbelt region in particular exhibits numerous power plants with outputs ranging from 10 MW – 1000 MW. Power plants in the southern region of DRC are generally of smaller capacity and more scarcely distributed. The adoption of the SEZ projects will require large power capacities, which will likely not be sustained from the nation grid(s). Investment opportunities exist in establishing strategically located power stations with respect to the location of the SEZs and the respective processing/manufacturing complexes, as well as the proximity to renewable energy sources (hydropower).                                                                                                                            |
| GHG emission | To curb CO <sub>2</sub> emissions and reduce power grid dependencies, investments should be directed towards expanding renewable energy sources such as hydro plants and solar farms. The DRC's main energy resource is hydroelectricity, with a very large potential of around 100 GW (30 % of the African continent, located on the Congo River and its tributaries, with more than 40 % of that potential situated on the site of Inga). So far, only 3 % of this hydroelectric potential has been developed, which nevertheless accounts for 96 % of domestic power generation. Similarly, Zambia has 2,800 MW of installed electricity generation capacity, of which 85 % is hydro based. SEZs in both nations should harness the largely untapped hydro renewable energy market to establish sustainable and reliable local power networks. |
| Water        | Water infrastructure surrounding the SEZ project development area(s) is largely subject to the project location(s). Requires further review upon project scope definition. Nevertheless, the vast water network in the DRC (Congo River) is expected to be harnessed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

**Table 75. Infrastructure assessment of the Special Economic Zone on battery value chains, DR Congo**

### 5.6.5 Further reading

Afreximbank (2023): Afreximbank and ECA sign Framework Agreement towards establishing Special Economic Zones for the production of Battery Electric Vehicles in DRC and Zambia.

<https://www.afreximbank.com/afreximbank-and-eca-sign-framework-agreement-towards-establishing-special-economic-zones-for-the-production-of-battery-electric-vehicles-in-drc-and-zambia%E2%82%AC/> (accessed 04.12.23)

African Development Bank Group (2015): Rail Infrastructure in Africa - Financing Policy Options. [https://www.afdb.org/fileadmin/uploads/afdb/Documents/Events/ATFforum/Rail Infrastructure in Africa - Financing Policy Options - AfDB.pdf](https://www.afdb.org/fileadmin/uploads/afdb/Documents/Events/ATFforum/Rail_Infrastructure_in_Africa_-_Financing_Policy_Options_-_AfDB.pdf) (accessed 12.03.24)

ARISE IIP (2023): Etude de préféabilité pour la mise en place de ZES pour les services de précurseurs de batteries électriques en République Démocratique du Congo et en Zambie. Internal report for project partners, 297 p.

AVZ (2020): AVZ delivers highly positive definitive feasibility study for Manono lithium and tin project. AVZ Minerals Ltd. <https://avzminerals.com.au/manono-project-definitive-feasibility-review> (last accessed March 3, 2024)

BloombergNEF (2021): The cost of producing battery precursors in the DRC. <https://repository.uneca.org/handle/10855/48054> (last accessed March 3, 2024)

Logistics Cluster (2022): Democratic Republic of Congo Railway Assessment. <https://dlca.logcluster.org/democratic-republic-congo-24-democratic-republic-congo-railway-assessment> (accessed 05.12.23)

IEA (2020): Democratic Republic of the Congo. <https://www.iea.org/countries/democratic-republic-of-the-congo> (accessed 07.12.23)

International Trade Administration (2022): Democratic Republic of the Congo - Country Commercial Guide – Energy. <https://www.trade.gov/country-commercial-guides/democratic-republic-congo-energy> (accessed 07.12.23)

## 6 Tailings reprocessing projects

Tailings and other mining residues in old mining districts (e.g., smelter slag) may represent valuable resources if they contain metals that were not of economic interest at the time of initial ore extraction. This may in particular refer to ECRM by-products that did not generate significant market demand at the time of the initial mining operations. Recent developments in processing technology may further support the economic recovery of residual ECRM contained in tailings.

Reprocessing of tailings is usually beneficial from an ESG perspective, since they have already been crushed and/or milled so that less energy is required for re-treating the material. Moreover, reprocessing old tailings may give rise to the opportunity to store tailings according to modern standards, with better managed environmental impacts and lower geotechnical risks. Old tailings are sometimes targeted by artisanal and small-scale miners, implying the need for operators and investors to consider an adequate socio-economic approach in such situations.

Overall, recovering ECRM from tailings may be considered as particularly beneficial, both from a financial and from an ESG perspective. However, while tailings, unlike new ore deposits, do not have to be 'discovered', there is still a certain risk in that tailings deposits are often of heterogeneous composition. Hence, their recoverable metal content needs to be carefully verified.

## 6.1 Kamativi tailings Li (-Sn-Ta-Nb) project (Zimbabwe)

Information as of 03/2024

### 6.1.1 General project background

|                                 |                                                                                                                                                                                                                                                         |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Lithium                                                                                                                                                                                                                                                 |
| <b>Other commodities</b>        | Tin, tantalum, niobium                                                                                                                                                                                                                                  |
| <b>Location</b>                 | Matabeleland North, Zimbabwe<br>18°19' S, 27°3' E, 800 – 1,050 m.a.s.l.                                                                                                                                                                                 |
| <b>License type</b>             | Mining Lease ML No. 12 (44.4 km <sup>2</sup> , granted in 1976)                                                                                                                                                                                         |
| <b>License owner / operator</b> | Kamativi Tailings Company (60 % Zimbabwe Lithium Company, 40 % Zimb. gov.); contended legal status                                                                                                                                                      |
| <b>Contact</b>                  | 1010 – 789 West Pender Street<br>Direct contact established: No<br>Vancouver, British Columbia V6C 1H2, Canada<br><a href="https://catstrategic.com/">https://catstrategic.com/</a><br><a href="mailto:info@catstrategic.com">info@catstrategic.com</a> |
| <b>Project status</b>           | Reserves Development, Under Litigation                                                                                                                                                                                                                  |
| <b>Production by 2030</b>       | Unlikely, but pegmatite tailings reprocessing projects only have a relatively short lead time                                                                                                                                                           |

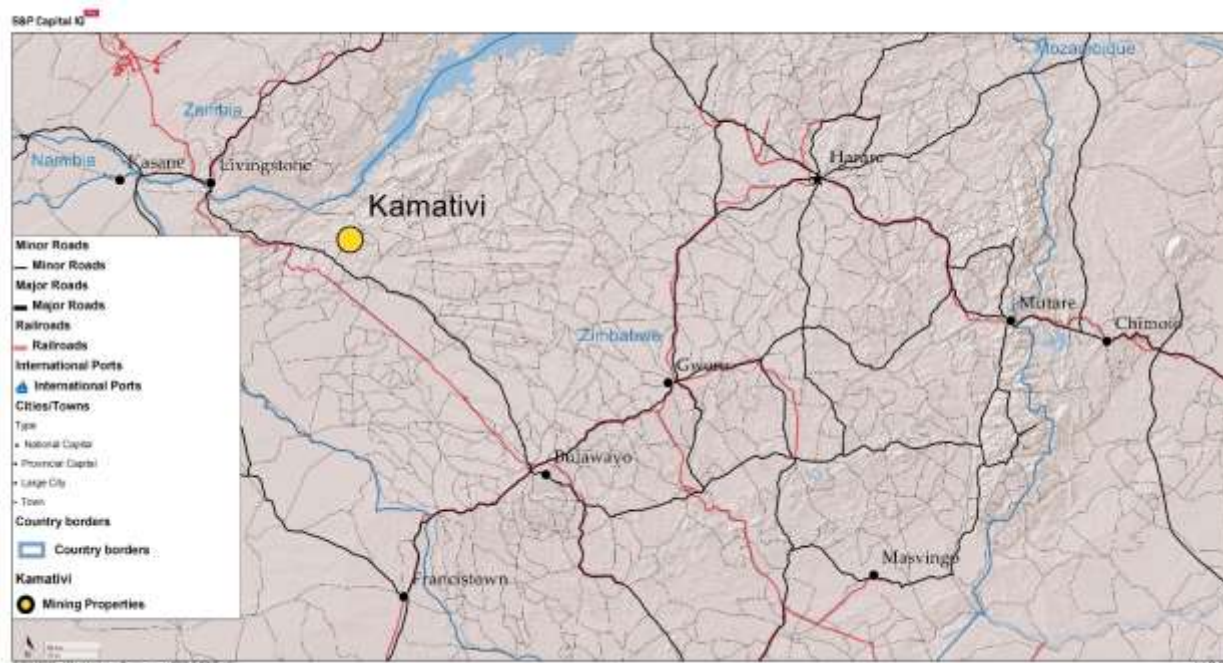


Figure 56. Kamativi tailings project location, Zimbabwe



### 6.1.2 Economic assessment

#### General project background:

The Kamativi tailings project is located 310 km northwest of Bulawayo. The tailings originate from 27 Mt of processed lithium-caesium-tantalum (LCT) pegmatite ore from the historic Kamativi mine (operated between 1936 and 1994). In total, an estimated 37 kt of tin and 3,000 t of tantalite have been produced from the mine. The lithium mineralisation (not extracted in the past) is primarily hosted in spodumene with minor cookeite, zinnwaldite, petalite and amblygonite. Tin mineralisation is hosted in cassiterite and tantalum in tantalite. CAT Strategic (formerly Chimata Gold) has an 18.9 % stake in the Zimbabwe Lithium Company (ZIM), which owned 60 % of the project. The project does not target Kamativi's primary pegmatite mineralisation but its historical tailings dump. There was a legal dispute over mining rights of the tailings dump between the Chinese-owned operator of Kamativi mine and ZIM. While the Zimbabwean High Court ruled in favour of the latter, the Supreme Court subsequently declared the project joint venture to be null and void. The legal implications for project development appear to be unclear. As of Q4/2018, CAT Strategic sought investment for a staged development of the project including stage 1 an initial dense medium separation and stage 2 additional flotation with production of concentrates for export or further refining. CAT Strategic also targeted a full takeover of ZIM through an earn-in agreement, which would ultimately give them 60 % ownership in the Kamativi tailings project. The company also seeks to develop other Li-bearing pegmatites identified in the region.

#### Project description:

|                                                                 |                                                                                                                                                                        |
|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                                                | Pegmatite tailings                                                                                                                                                     |
| NI 43-101 compliant resources @ 0.2 % Li <sub>2</sub> O cut-off | 26.6 Mt @ 0.58 % Li <sub>2</sub> O, 494 g/t Sn, 41 g/t Ta <sub>2</sub> O <sub>5</sub> , 65 g/t Nb <sub>2</sub> O <sub>5</sub>                                          |
| Share of global lithium resources                               | 0.07 % ( <i>USGS estimate global Li<sub>2</sub>O resources of 211 Mt</i> )                                                                                             |
| Share of global tin resources                                   | 0.18 % ( <i>BGR estimate* global Sn resources of 7.5 Mt</i> )                                                                                                          |
| Waste to ore ratio (whole orebody)                              | Expected to be low due to direct access to the tailings                                                                                                                |
| Annual production                                               | Assumed at ~100 kt of SC6                                                                                                                                              |
| Life of mine                                                    | Not defined by company; >15 years possible when assuming an annual production of ~100 kt of SC6 and a Li <sub>2</sub> O recovery of 72 %                               |
| Investment required                                             | US\$ 385,000 (for further exploration and economic assessment)                                                                                                         |
| Net present value (NPV)                                         | Not announced                                                                                                                                                          |
| Share of global lithium production                              | 2.1 % ( <i>USGS estimate global Li<sub>2</sub>O production of 280,000 t</i> )                                                                                          |
| Value addition potential                                        | Resource upside potential through brownfield exploration due to project location in an extensive pegmatite belt with high prospectivity for lithium, tin and tantalum. |

#### Mining and processing:

- The Project is accessible via the tarred A8 road from Hwange (~55 km) and by a secondary tarred road (~30 km). The nearest railhead, albeit in need of repair, is located in the town of Dete,

about 45 km southwest of Kamativi and is part of the Bulawayo-Hwange-Victoria Falls line. The old mine and the village of Kamativi are supplied via a 33 kV overhead line from Hwange. There is a 33/11 kV substation near the old Kamativi processing plant that needs to be maintained and modernised if connection to the national grid is envisaged. The old Kamativi mine was supplied with water via the Kamativi Dam, supplemented by water from the Gwayi River.

- The tailings material is a product of mining, crushing and milling of the historic Kamativi operation. CAT Strategic envisages hydromining with subsequent classification of the material at 400 to 500 µm by screening equipment or cycloning. An initial (stage 1) dense media and magnetic separation is considered for the coarse material. Preliminary test work recorded concentrate assays as 7.1 % Li<sub>2</sub>O (recovery of ~72 %), 0.11 % tin (recovery of 38 %) and 0.26 % iron. In a later stage of the project (stage 2), additional flotation of the fine material (<400 µm) with subsequent magnetic separation is planned.
- Tin is concentrated via crushing (no milling required due to coarse grain size), spiral classification, dense media separation, shaking tables, and magnetic separation to produce final tin and tantalum concentrates. The concentrate grade is >60 % tin with very low grades of uranium and thorium, which minimizes potential transport and smelting issues of the concentrate. The tin recovery rate is 65-70 %, which is high for a density separation process.
- In 01/2019, Transamine Trading S.A. and Kamativi Tailings Company signed a term sheet for a US\$ 9.5m financing and offtake agreement for concentrate from the project. However, in 05/2019, the company announced that due diligence on this agreement has been suspended.

#### **BGR assessment and comments:**

- The deposit is a low-grade, medium-tonnage operation with no direct waste, but material that is too fine to be processed. There is a potential to increase the resources, as the operator seeks to explore for primary lithium-tin-tantalum deposits around the old mine site. Given that only resource estimates have been made to date, infill drilling and a preliminary economic assessment are recommended. More detailed metallurgical work is recommended to determine the most efficient workflow and to ensure safe removal of iron (deleterious element). Additional separation steps would be necessary to recover cassiterite concentrates as a valuable by-product.
- Zimbabwe has a lithium mining-friendly policy that grants special economic zone status for certain projects, which includes exemption from certain taxes, royalties and dividends, as well as tax exemptions for capital goods.
- The extraction rights for the tailings dump were previously segregated from the mining rights; the holder of the mining rights appealed this decision. The current status of the mining rights appears to be ambiguous. With the Zimbabwean Supreme Court ruling of 01/2023 declaring the project JV as null and void, it is unclear whether ZIM and its subsidiary, Jimbata Ltd.,

still have access to the project. A recent newspaper article suggests that Kamativi Mining Company (a JV partly owned by Chinese-listed Yuhua Group) started constructing a dense media separation plant at the tailings dump. Potential investors are therefore advised to perform due diligence on the project to clarify the legal situation.

### 6.1.3 ESG assessment

Due to the early stage of the project and overall rudimentary reporting of CAT information in several ESG categories are not yet available. So far no ESG issue could be identified that could not be handled by diligent management and operational practice. Access to clean water for local communities is currently limited due to derelict infrastructure, the Kamativi project provides an opportunity in this regard by overhauling the local infrastructure. Zimbabwe is considered a high-risk area due to human rights violations including against the political opposition and activist in the recent past. Endemic corruption, weak rule of law, and poor protections for workers and land rights are critical challenges.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Environmental management                                           | No information on general environmental policies on companies' website; no detailed information on environmental management available; no reports on any incidents found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Efficient use of energy, renewable energy, GHG emissions reporting | No information on power demand at this project stage. Previous mining operation was supplied by grid power; Zimbabwean grid 70 % hydropower and 30 % coal power.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Water management and consumption                                   | Semi-arid area with low water stress, rainy season between November to March (precipitation 635 mm). No information on water demands available at this project stages. Water supply for previous mining operations were taken from the Kamativi river respectively the Kamativi dam which runs close to the project and supplemented from the Gwayi River around 2.5 km south; additional seasonal streams located in the area. Water for the community is taken directly from the Kamativi dam and three boreholes; water sources are reported to be contaminated and the sewage system is dysfunctional leading to diseases like diarrhoea, dysentery and cholera. It is highly recommended to overhaul the local water supply infrastructure to avoid conflicts on water use. |
| Pollution prevention                                               | No specific information on AMD potential available. Sampling of the tailings indicating a lesser U and Th content of 12 ppm respectively 2.28 ppm on average. Flotation technology, as part of the anticipating processing, may imply use of hazardous reagents.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Air quality                                                        | Proximity to settlements will require dust suppression measures (e.g. sprinkling of roadways and TSF).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Tailings management                                                | Tailings disposal after reprocessing possible as in-pit disposal or by constructing a new TSF; in-pit disposal will reduce the effective overall land use footprint, but will complicate the operations as extraction and disposal                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

| ESG category                                                                                         | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                      | need to be parallel; construction of a new TSF will increase the land use, however, as the region is not intensively used for agriculture activities the additional land acquisition might be reasonable.                                                                                                                                                                                                                                                 |
| Waste management                                                                                     | No information waste management available at this project stage.                                                                                                                                                                                                                                                                                                                                                                                          |
| Hazardous materials management                                                                       | Flotation technology and use of reagents is considered low risk assuming responsible handling; no specific information on reagents available.                                                                                                                                                                                                                                                                                                             |
| Noise and vibration                                                                                  | Proximity to settlements will require noise suppression measures (e.g. construction of noise barriers).                                                                                                                                                                                                                                                                                                                                                   |
| Protected areas and biodiversity                                                                     | The project is not located in or close to any key biodiversity areas or other designated protected areas. Reworking of historic tailings, rehabilitation effort resulting up to now in grass cover and occasional scrubs on the tailings site; region in general dominated by dry grassland, and scrub and woodland areas restricted to the river valley and hills. No specific information on biodiversity available; negative impact assumed to be low. |
| Mine closure                                                                                         | No information on any liabilities for any historic mining activities; no mine closure planning available at this project stage.                                                                                                                                                                                                                                                                                                                           |
| <b>Social and socio-economic issues</b>                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Community health, safety and security                                                                | The village of Kamativi (~7,000 inhabitants) is neighbouring the project in the east to south. Major economic activities in the region are ranching, hunting, and wildlife tourism. Local infrastructure is described as derelicted, considering especially lacking water treatment capabilities to supply the local community with clean water; the project holds the opportunity to initiate the overhaul of local infrastructure.                      |
| Dialogue and engagement with communities and stakeholders                                            | No information on stakeholder engagement available yet.                                                                                                                                                                                                                                                                                                                                                                                                   |
| Land acquisition and involuntary resettlement                                                        | Due to reworking of historic tailings assuming negligible needs for land acquisition; an exception would be the construction of a new TSF instead of in-pit disposal.                                                                                                                                                                                                                                                                                     |
| Occupational health & safety management                                                              | No information available at this project stage.                                                                                                                                                                                                                                                                                                                                                                                                           |
| Workers' rights                                                                                      | Zimbabwe scores 71.5/100 in the Labour Rights Index; no evidence of practice by CAT yet.                                                                                                                                                                                                                                                                                                                                                                  |
| Gender and diversity                                                                                 | No information available at this project stage.                                                                                                                                                                                                                                                                                                                                                                                                           |
| Local value added and community development                                                          | The village of Kamativi impoverished after end of tin mining activities and loss of the associated jobs; the project holds the opportunity to recreate some of the lost jobs, improve derelicted local infrastructure (especially water supply), and provide other CSR measures.                                                                                                                                                                          |
| <b>Governance</b>                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Legal compliance  | Ambiguous legal situation; mining rights over tailings contended.                                                                                                                                                                                                                                                                                                                                                                                         |

| ESG category               | Assessment                                                                                                                                                                                                                                                                                                                            |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Management practices       | No specific information on management practice available on company website.                                                                                                                                                                                                                                                          |
| Transparency and reporting | Listed on CSE and XFRA; limited information for investors and reports on financial accounts and shareholder structure available.                                                                                                                                                                                                      |
| Business ethics            | Zimbabwe scores 24/100 in the Corruption Perception Index. Zimbabwe is considered a high-risk area (CAHRA), due to reports on human rights violations in conjunction with the violently suppression of the freedom of expression. Zimbabwe is not an EITI country. No indication of any unethical practices on the side of CAT found. |

Table 76. ESG features of Kamativi tailings project, Zimbabwe

### 6.1.4 Infrastructure assessment

#### Potential Investment Needs:

- **Railway Enhancements:** Upgrade material handling facilities at Dete railway station to ensure a capacity of up to 150,000 t/a can be managed. Current upgrade of the North-South Rail Corridor should suffice to meet project demands.
- **Renewable Energy Ventures:** Given the increasing emphasis on reducing CO<sub>2</sub> emissions, investments might be channelled into potential renewable energy sources, e.g., solar energy. 20 MW solar plant costs between US\$ 11m and US\$ 30m – case study in Seke, Zimbabwe: US\$ 25m.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | The brownfields project is located at the historical Kamativi Tin Mine in the northwest of Zimbabwe. As such, substantial infrastructure already exists, e.g., housing, office buildings, asphalt roads, electrical sub-station., etc.                                                                                                                                                                                                                                                                                                                                                                                 |
| Transport                 | The project can be readily accessed by national highway A8. At the Dete/Kamativi intersection, approximately 29 km of asphalt road leads NE to the Kamativi operation, whereas approximately 17 km of asphalt road leads SW to the municipality of Dete, providing access to the rail network. Investments into the truck fleet and road facilities may be necessary for the project.                                                                                                                                                                                                                                  |
| Airport                   | Kamativi lies approximately 185 km from Victoria Falls international airport and 315 km from Bulawayo international airport. Both airports connect directly to the A8 national highway and can transport both passengers and materials.                                                                                                                                                                                                                                                                                                                                                                                |
| Rail access               | The nearest rail station is at Dete and operates on the Victoria Falls – Bulawayo rail line. The projects 2 near-lying airports are connected by this line. From Bulawayo, connections to the port cities of Beira and Maputo in Mozambique, and Durban in South Africa, are available. All railways within Zimbabwe are maintained and operated by the National Railways of Zimbabwe (NRZ). NRZ moved a total of 2.3 Mt of cargo in 2022, missing its target of 3 Mt due to operational inefficiencies. NRZ recently signed a contract with the government of India to improve the operational capacity of the system |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | by 2.5 Mt per annum (total of 4.8 Mt/a) by means of a US\$ 81.2m investment in operating infrastructure.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Port         | The Port of Beira in Mozambique is nearest port to the Kamativi Tailings Project and is accessible by existing road and rail networks. The port is managed by Cornelder de Moçambique, a joint venture between Moçambique Ports and Railways (CFM) and Cornelder Holdings in Rotterdam. Current container capacity is approximately 400,000 TEUs annually. The container storage facility accommodates up to 11,200 TEUs, with dedicated storage areas for cool/frozen consumables and dangerous goods. The port comprises of two piers with depths ranging between 8 m and 12 m, accommodating ships with a maximum draught and length of 7 m and 140 m, respectively. |
| Energy       | The Kamativi mine and village is fed by a 33 kV overhead powerline from Hwange. A 33/11 kV substation is located near the old Kamativi processing plant with a single 2,000 kVA 33/11 kV transformer installed. The transformer has a 2,200 V tertiary winding which appears to be disconnected. This substation is equipped to supply two transformers, one of which has been removed. Reticulation around the site includes five 11 kV overhead lines with separate transformers and meters. Project plans to refurbish existing power infrastructure.                                                                                                                |
| GHG emission | To curb CO <sub>2</sub> emissions and reduce power grid dependencies, investments should be directed towards renewable energy sources like solar farms. Solar is the most prominent form of renewable energy in the region. Government planned to invest in 20 MW solar power farm (2020) to support the Kamativi Tailings Project. China Energy Engineering Corporation proposed to install a 1,000 MW floating solar farm on Lake Kariba – a US\$ 1bn investment (28.03.23).                                                                                                                                                                                          |
| Water        | Historically, the Kamativi mining operation obtained water for processing from the Kamativi dam, situated south of the mining town and built on the Kamativi River. Water from the Kamativi dam was supplemented with water from the Gwayi River (to the southwest of the Property), sourced from a weir built midway between the old and new bridges that span the river. The 33 kV power line crosses the river at this point and could be used (and probably was used when the mine was in operation) to supply power to the pump(s) if water is required for the proposed operations. A backup power supply should also be considered if necessary.                 |

**Table 77. Infrastructure assessment of Kamativi tailings project, Zimbabwe**

### 6.1.5 Further reading

AAA (2023): Whether an arbitration agreement embedded in an agreement which is null and void is also a nullity? African Arbitration Association analysis. <https://afaa.ngo/page-18097/13255718> (accessed 26.03.2024)

Cat Strategic Metals Corp. (2022a): Kamativi Lithium Tailings Project – Zimbabwe. <https://catstrategic.com/wp-content/uploads/2022/10/FINAL-Kamativi-Lithium-Presentation-v.3-SC.pdf> (accessed: 02.02.2024)



Cat Strategic Metals Corp. (2022b): Acquiring and Developing Strategic Global Mineral Projects. <https://catstrategic.com/wp-content/uploads/2022/10/CAT-STRATEGIC-CORP-PRESENTATION-SC-Edit.pdf> (accessed: 02.02.2024)

Chronicle (2020): Legal wrangle stalls US\$ 1.4 bn Kamativi project. <https://www.chronicle.co.zw/legal-wrangle-stalls-us14bn-kamativi-project/> (accessed 26.03.2024)

Chronicle (2024): Kamativi tin mine: A gift that keeps on giving. <https://www.chronicle.co.zw/comment-kamativi-tin-mine-a-gift-that-keeps-on-giving/> (accessed 26.03.2024)

MSA (2018): NI 43-101 Technical Report. [NI43-101TechnicalReport-Kamativi-Li-Nov-2018.pdf](#) ([sectornewswire.com](https://sectornewswire.com)) (accessed 16.11.2023)

## 6.2 Manono (tailings) Li (-Sn-Ta) pegmatite project (DR Congo)

Information as of 11/2023

### 6.2.1 General project background

|                                 |                                                                                                                                                                                                                                                                              |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Lithium                                                                                                                                                                                                                                                                      |
| <b>Other commodities</b>        | Tin, tantalum                                                                                                                                                                                                                                                                |
| <b>Location</b>                 | Tanganyika, Dem. Rep. Congo<br>7°17' S, 27°24' E, 600 – 700 m.a.s.l.                                                                                                                                                                                                         |
| <b>License type</b>             | Tailings Exploitation Permit PER 13698                                                                                                                                                                                                                                       |
| <b>License owner / operator</b> | 52 % Tantalex Lithium Res. Corp. (operator, public company), 18 % MINOR (private company), 30 % Cominière (DRC government)                                                                                                                                                   |
| <b>Contact</b>                  | 1410-120 Adelaide Street West<br>Toronto, Ontario M5H 1T1, Canada<br><a href="https://tantalexlithium.com">https://tantalexlithium.com</a><br><a href="mailto:info@tantalex.ca">info@tantalex.ca</a><br>Eric Allard, CEO, <a href="mailto:ea@tantalex.ca">ea@tantalex.ca</a> |
| <b>Project status</b>           | Reserves Development - Prefeasibility/Scoping                                                                                                                                                                                                                                |
| <b>Production by 2030</b>       | Announced for 2026 (lithium); tin-tantalum recovery already active                                                                                                                                                                                                           |

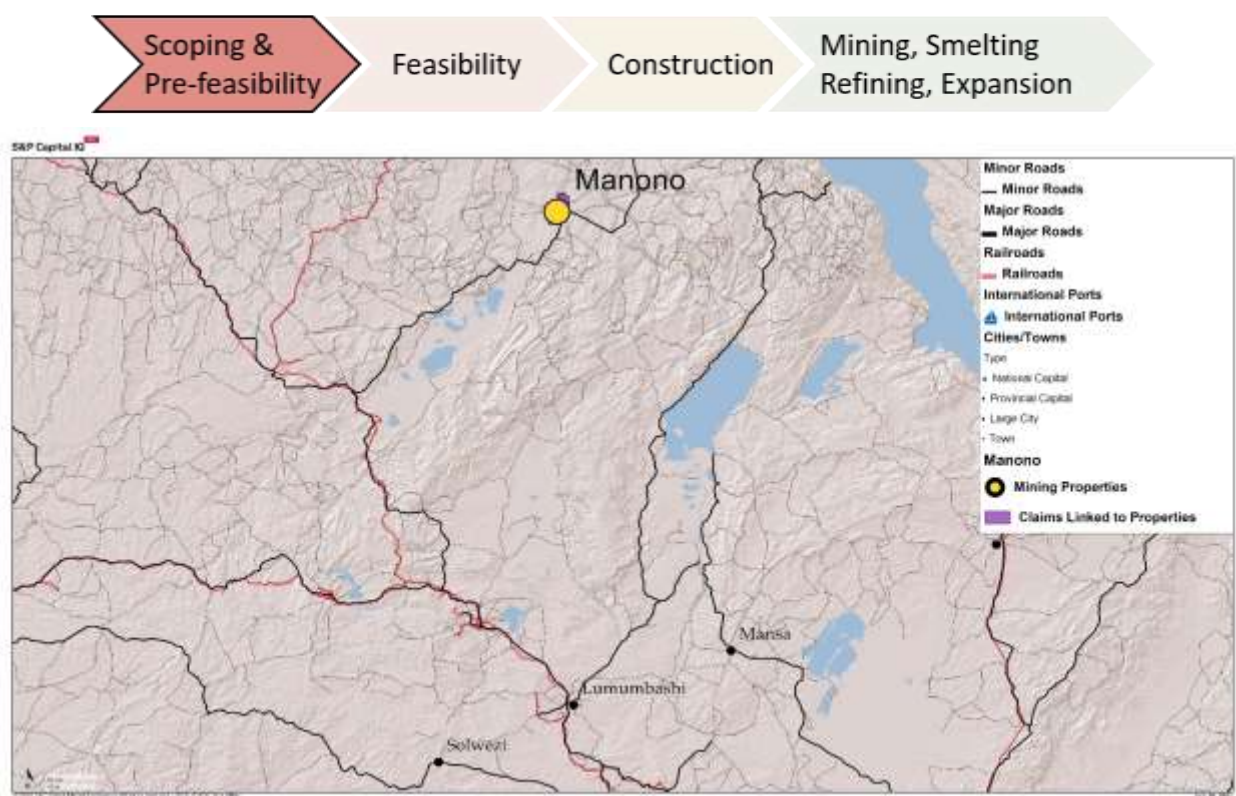


Figure 57. Manono project location, DR Congo

## 6.2.2 Economic assessment

### General project background:

Tantalex' Manono tailings project is located 490 km north of Lubumbashi. The tailings originate from the processing of pegmatites from the historic Manono-Kitolo tin mine (operated from 1919 until the mid-1980s). In total, an estimated 140 kt to 185 kt of tin and 4.5 kt of coltan concentrate were extracted from the mine. The tailings consist of a mixture of material, typically pegmatite and laterite, with minor clay material. Tantalex' exploration permit comprises 11 tailings dumps spanning a length of 12 km from the southwest towards the northeast. The tailings are named alphabetically, with a suffix used to differentiate between coarse (c) and fine (f) material, including from north to south named Cc, Cf, Ec, Hc, Hf, Gc, Gf, Ic and K. The lithium mineralisation (not extracted in the past) is primarily hosted in spodumene with minor lepidolite. Tin mineralisation is hosted in cassiterite and tantalum in tantalite. Tantalex expects the completion of a Definitive Feasibility Study in 12/2024 and targets SC5.5 lithium concentrate production by 2026. The project requires investment for feasibility studies, on- and off-site infrastructure as well as for the construction of the mine and processing plant. Tantalex completed a term sheet with Glencore in November 2023 for the marketing rights of all production.

### Project description:

|                                                 |                                                                                                                |
|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Ore deposit type                                | Tailings of historically mined pegmatites and laterites                                                        |
| NI 43-101 compliant resources                   | 11.9 Mt @ 0.61 % Li <sub>2</sub> O; 8.9 Mt @ 416 g/t Sn, 28 g/t Ta                                             |
| Share of global lithium resources               | 0.03 % ( <i>USGS estimate global Li<sub>2</sub>O resources of 211 Mt</i> )                                     |
| Waste to ore ratio (whole orebody)              | Not yet available                                                                                              |
| Annual production                               | 112 kt of concentrate (5.5 % Li <sub>2</sub> O), 2,860 t Li contained metal                                    |
| Life of mine                                    | 7 years                                                                                                        |
| Investment required                             | US\$ 150m (refers to the total CAPEX)                                                                          |
| Net present value (NPV)<br>(Pre-tax)            | US\$ 765m (based on a SC6 price of US\$ 2,800/t and a discount rate of 10 %)                                   |
| Share of global tin production<br>(phase 2)     | 2.9 % (10 Mt of ore per year, recovery 70 %)<br>( <i>USGS estimate global Sn production of 310,000 t</i> )     |
| Share of global lithium production<br>(phase 2) | 2.2 % (recovery 63 %)<br>( <i>USGS estimate global Li<sub>2</sub>O production of 280,000 t</i> )               |
| Value addition potential                        | <i>The lithium concentrate could be further processed in the proposed special economic zone (Chapter 5.6).</i> |

### Mining and processing:

- The Manono tailings project is located ~490 km north of Lubumbashi and between the mining towns of Manono and Kitotolo. A compacted gravel and sand road will serve as the primary access point to the project. This road connects to the N33, which is the main access road to the towns of Manono and Kitotolo from Lubumbashi. The final 240 km of the N33 between Likasi and Manono is an unpaved road that is prone to wash outs in rainy season. Tantalex has allocated an allowance of US\$ 10m in the CAPEX for improving this road including several bridges.

The power requirements for the overall plant, including both mining and processing is 4.0 MW and is planned to be mainly supplied by diesel generators. However, Tantalex will look at a solar hybrid solution during the engineering phase and may well receive its power from the Mpiana mwanga hydroelectric dam, currently being rehabilitated by Katamba Mining. The city of Manono is currently powered by a solar power plant (1 MW) that was commissioned in 03/2018.

- The tailings dumps will be reclaimed by an excavator at each of K, I and G dumps and loaded onto dump trucks for transport onto an overland conveyor that will feed a stockpile at the processing plant. Material from the tailings dumps will be processed to a spodumene concentrate with a  $\text{Li}_2\text{O}$  grade of 5.5 % (SC5.5) using a process flowsheet consisting of tertiary crushing, dense media separation, and flotation, dewatering and bagging plants. The lithium recovery rate is expected to be >63 %.
- Tantalex negotiated a marketing offtake agreement with Glencore for 100 % of the lithium to be produced from the company's Manono tailings project, from the date of the start of commercial production throughout life of mine. Glencore shall have the sole responsibility for all sales and will contribute US\$ 5m during the project development phase plus one third of the total CAPEX.

#### **BGR assessment and comments:**

- The deposit is a medium-grade, medium-tonnage lithium operation with a low waste to ore ratio. The mine life is short (7 years), reflecting mining of tailings only. The advantage of mining tailings is that the project might be brought into production rather quickly. Resource expansions are possible because only 3 of the 11 dumps are currently included in the PEA report. The PEA has been made for processing of 7.8 Mt of ore whereas further exploration and development on the other tailings can significantly improve the total production and life of mine.
- In the current project phase, almost 50 % of the resources are classified as inferred due to the geometry of the dumps, whereby drill holes were technically too difficult to drill in the slope areas of the tailings. Tailings can be very heterogeneous and potential mineral enrichments are difficult to predict. It is therefore critical that a feasibility study is carried out to provide a final assessment of the economic viability of the project. This study should also take into account the potential contribution of tin and tantalum concentrates as by-products.
- The operating expenditures are modelled at US\$ 404.50/t of concentrate; these production costs are low, reflecting the processing of tailings (which, unlike most primary ore, do not require expensive crushing). However, Tantalex assumes an SC5-6 sales price of US\$ 2,800/t while the average SC5-6 price for the last 5 years (2018-2022) was ~US\$ 1,800/t. BGR recommends more conservative price estimates, especially in the context of Li price slumps since end of 2022.

### 6.2.3 ESG assessment

Because of the early stage, project specific information about the ESG practice are not yet available. An environmental impact study will be part of the mining license application. The reprocessing of the tailings will require the movement of large masses and the creation of a new central tailings dump close to the processing plant. This could improve the general environmental situation since the new dump could be engineered for stable closure and revegetation. Since the tailings were derived from the processing of pegmatite ore, they can be considered as chemically inert requiring only a cover of topsoil to provide a substrate adequate for revegetation. Satellite images show significant ASM activities on and around the former mine site. However, it is not clear if ASM is still active. Technical and environmental information for pollution prevention, air quality, tailings and waste management, hazardous material, noise and vibration and mine closure has to be included in the application for the renewal of the exploration permit in 2023.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Environmental management                                           | Only general information is available. The company structure contains a management position dedicated to ESG topics. There is no track record of incidents known from Tantalex. The ESIA is expected in Q4/2024.                                                                                                                                                                                                                                                                                                                                                                                             |
| Efficient use of energy, renewable energy, GHG emissions reporting | The power requirements for mining and processing is 4.0 MW. The PEA has assumed electrical power will be supplied by three 2.5 MW diesel generators. Diesel consumption of the generators is calculated at 8.2 million l/a; 1.4 million l/a is required for the mobile equipment fleet. Power for the mining camp is generated by a photovoltaic plant. Solutions are envisaged for hydroelectricity and/or solar hybrid during the Feasibility Study.                                                                                                                                                       |
| Water management and consumption                                   | In the planned flotation and dense media separation plant, water will be used as transport and processing medium. Water will be recycled from the thickener overflow. The company plans to collect storm water and surface runoff by trenches around the perimeter of the process plant and direct it to a settling pond. The operation will require 52 m <sup>3</sup> /h of process water and 10 m <sup>3</sup> /d of potable water that will be sourced from a newly drilled well within the concession. Sewage and wastewater will be treated. The water stress at the mining location is considered low. |
| Pollution prevention                                               | No AMD potential from geology, however in the flotation process chemicals would be used. Further information not yet available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Air quality                                                        | Information not yet available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Tailings management                                                | TSF will receive tailings from the dense media separation and the flotation plant. The TSF is sized to store a total of 10 million t of tailings, over the six-year plant life. The final tailings pile does not exceed a height of 24 m and will be lined with a membrane at its base.                                                                                                                                                                                                                                                                                                                      |
| Waste management                                                   | Information not yet available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Hazardous materials management                                     | The dense media separation plant will use ferrosilicon (FeSi) as the densifying agent. The FeSi will be stored in waterproof steel drums under                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

| ESG category                                                                                                                                | Assessment                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                             | a roof. The flotation plant will require several types of reagents that will be stored in plastic totes under a roof.                                                                                                                                                                                                                                                                                              |
| Noise and vibration                                                                                                                         | Information not yet available.                                                                                                                                                                                                                                                                                                                                                                                     |
| Protected areas and biodiversity                                                                                                            | The region supports a variety of vegetation that ranges from dense humid forest and clear forest to savannah and meadowlands. There is no key biodiversity area close to the project site.                                                                                                                                                                                                                         |
| Mine closure                                                                                                                                | Information not yet available. However, the project involves reworking of old tailings which have not been properly rehabilitated. Therefore, formal mine closure should thus have a (net) positive impact on the site.                                                                                                                                                                                            |
| <b>Social and socio-economic issues</b>                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Community health, safety and security                                                                                                       | Expected impacts on local communities are not yet investigated, however Tantalex assures that local communities derive a lasting benefit from the mining operation. Tantalex has recently partnered with NGO “Upright Africa” to provide medical care for the local community.                                                                                                                                     |
| Dialogue and engagement with communities and stakeholders  | There is no evidence of structured dialogue with local communities and no information on conflicts with communities. Satellite images indicate past ASM activities around the project site; requires verification and integration of potential ASM workers into stakeholder engagement.                                                                                                                            |
| Land acquisition and involuntary resettlement                                                                                               | No information available. The mining zone is scarcely populated. There are no world heritage sites close to the mining project.                                                                                                                                                                                                                                                                                    |
| Occupational health & safety management                                                                                                     | Risk of hazards related to technology/production of tailings reprocessing is considered as low; no detailed information available.                                                                                                                                                                                                                                                                                 |
| Workers' rights                                                                                                                             | According to the Labour Rights Index in the DRC there is generally limited access to decent work; no specific information available.                                                                                                                                                                                                                                                                               |
| Gender and diversity                                                                                                                        | No information available.                                                                                                                                                                                                                                                                                                                                                                                          |
| Local value added and community development                                                                                                 | The company claims that the current exploration and development work is beneficial to the communities as road improvements shall make Manono more accessible and help improving the local economy.                                                                                                                                                                                                                 |
| <b>Governance</b>                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Legal compliance                                                                                                                            | Compliant with applicable laws, relevant mining licenses are available.                                                                                                                                                                                                                                                                                                                                            |
| Management practices                                                                                                                        | No further Information on ESG topics and management related to the project is available.                                                                                                                                                                                                                                                                                                                           |
| Transparency and reporting                                                                                                                  | Tantalex has a public disclosure policy and is listed on the CSX, the XFRA and US-OTCQB Venture Market with relevant investor information on its website.                                                                                                                                                                                                                                                          |
| Business ethics                                                                                                                             | Tantalex has a code of business conduct and ethics for directors. The project is located in the province of Tanganyika that is considered high-risk area according to the EU CAHRA list. Tantalex has published a conflict minerals policy and taken steps in addressing the issue of conflict minerals in its supply chain. The Corruption Perception Index score of the DRC is 20 (ranked 162 of 180 countries). |

Table 78. ESG features of Manono (tailings) project, DR Congo



## 6.2.4 Infrastructure assessment

### Potential Investment Needs:

- **Road Infrastructure:** Road infrastructure between Manono and Lubumbashi requires rehabilitation to handle transportation needs, estimated investment need of US\$ 10m.
- **Railway Enhancements:** Development of Lobito Corridor project, estimated investment need of US\$ 1.6bn.
- **Renewable Energy Ventures:** Upgrade / expansion of existing local power grid – harness available and accessible renewable energy sources (hydro and solar).

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | Infrastructure in the adjacent mining towns of Manono and Kitotolo is limited. Power supply to the township of Manono is generated by a 1 MWp solar power plant that was commissioned in March 2018. The solar power plant is the largest off-grid solar power plant in the region and supplies a new isolated network of the Société Nationale d'Électricité (SNEL). A small hospital is found in the township of Manono.                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Transport                 | The project is accessible from Lubumbashi in the south-east of DRC via road (approximately 630 km). The vast portion of this road segment is unpaved. The N1 national highway leads from Lubumbashi to Likasi for 125 km before deviating north for 44 km along another sealed road. Thereafter, the passage deviates to a dirt road for 29 km, rejoins a sealed road for a further 19 km, and finally continues the remaining 420 km on unsealed roads (including the intersection with the N33). From Lubumbashi, saleable product will be transported by truck to the port of Dar es Salaam in Tanzania. It is assumed that the T3 and T2 national highways in Zambia and the A104 and A7 national highways in Tanzania will be fully utilised for this purpose.                                                                                                                           |
| Airport                   | A local airport in Manono (Lapangan Terbang Manono) connects the project area with Lubumbashi international airport via a scheduled 1.5-hour flight. The airport at Manono is public and consists of a 1.37 km gravel runway. Therefore, heavy material will be trucked from Lubumbashi and larger equipment directly from the desired port of Dar es Salaam.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Rail access               | The Project is approximately 215 km south of the Kongolo Railway station on the second section of the Great Lakes Line. In southern parts of DRC, the national railway line is mostly operated by the Société Nationale des Chemins de Fer du Congo (SNCC). Railway lines are not all linked but are generally connected by river transport. Infrastructure in the project area is fragmented and requires rehabilitation and/or modernisation. From Lubumbashi, rail infrastructure towards Lusaka, Zambia, intercepts the TAZARA (Tanzania-Zambia-Railway) line, consequently leading to the port of Dar es Salaam. Similarly, strong financial backing in the “Lobito Corridor” project, connecting the Zambian Copperbelt with existing rail infrastructure in Angola. Memorandum of understanding signed by US, Angola, DRC, Zambia, and the European Commission. Estimate: US\$ 1.6 bn. |
| Port                      | From Lubumbashi, Tantalix Lithium Resources plans to transport the palletised bags onto 26 t trucks for approximately 2,080 km to the port of Dar es Salaam, Tanzania. The port is managed by Tanzania Ports Authority and is currently undergoing projects for its                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | modernisation. Current container capacity is approximately 660,000 TEUs annually. The container storage facility accommodates up to 64,463 m <sup>2</sup> of bagged cargo (breakbulk) and 201,613 m <sup>2</sup> of general cargo (container). The port has one dry-cargo berth and one container berth with a depth of ranging between 8.7 m and 10.5 m, accommodating ships with a maximum length and breadth of 234 m and 140 m, respectively.                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Energy       | The power requirement for the overall plant, including every operational step, is 4.0 MW. Electrical power to the plant will be supplied by three 2.5 MW diesel generators, with two operating and one standby. Investment opportunity to upgrade Manono solar plant or to build a strategically located solar plant proximal to the project with the potential to add to the local grid.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| GHG emission | To curb CO <sub>2</sub> emissions and reduce power grid dependencies, investments should be directed towards expanding renewable energy sources like hydro and solar power. Weather conditions in the region are overcast for approximately 50 % of the year, threatening the efficiency and suitability of solar. Nevertheless, the flexibility to construct off-grid solar farms may prove resourceful. The DRC's main energy resource is hydroelectricity, with a very large potential of around 100 GW (30 % of the African continent, located on the Congo River and its tributaries, with more than 40 % of that potential situated on the site of Inga). So far, only 3 % of this hydroelectric potential has been developed, which nevertheless accounts for 96 % of domestic power generation. Investment potential in hydro proves the most reliable and abundant in the region. |
| Water        | Based upon the mass balance, the process will require 52 m <sup>3</sup> /h of make up for process water and 10 m <sup>3</sup> /d of potable water. These water sources will be sourced from newly drilled wells within the site boundary limits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

**Table 79. Infrastructure assessment of Manono project, DR Congo**

### 6.2.5 Further reading

Sedgman Novopro (2023): Preliminary Economic Assessment Report for the Manono Lithium Tailings Project Manono, Democratic Republic of Congo. <https://tantalexlithium.com/wp-content/uploads/2023/10/PR1208-001-00-Manono-Tailings-PEA.pdf> (accessed 29.12.23)

Tantalex Lithium Resources Corp. (2022): Manono Tailings Project. Democratic Republic of Congo. NI 43-101 Technical Report – 13 December 2022 Mineral Resource Estimate. [https://tantalexlithium.com/wp-content/uploads/2023/01/NI-43-101-Mineral-Resource-Estimate Manono-Tailings-Project -January-2023.pdf](https://tantalexlithium.com/wp-content/uploads/2023/01/NI-43-101-Mineral-Resource-Estimate-Manono-Tailings-Project-January-2023.pdf) (accessed: 27.11.2023)

Tantalex Lithium Resources Corp. (2023a): Minerals That Are Shaping Our World. Corporate Presentation October 2023. [https://tantalexlithium.com/wp-content/uploads/2023/10/Tantalex-Lithium-Corporate-Presentation Oct-2023.pdf](https://tantalexlithium.com/wp-content/uploads/2023/10/Tantalex-Lithium-Corporate-Presentation-Oct-2023.pdf) (accessed: 27.11.2023)

Tantalex Lithium Resources Corp. (2023b): Tantalex Lithium concludes with Glencore for lithium marketing and \$US 5 million plus one third of capex in financing.

<https://tantalexlithium.com/tantalex-lithium-concludes-with-glencore-for-lithium-marketing-and-us-5-million-plus-one-third-of-capex-in-financing/> (accessed: 28.11.2023)

Tantalex Lithium Resources Corp. (2023c): Tantalex Lithium resources Files NI 43-101 preliminary economic assessment report for the Manono lithium tailings project. <https://tantalexlithium.com/tantalex-lithium-resources-files-ni-43-101-preliminary-economic-assessment-report-for-the-manono-lithium-tailings-project/> (accessed: 28.11.2023)

Tantalex Lithium Resources Corp. (2023d): Tantalex Lithium announces start of commissioning on its TiTan tin and tantalum plant. <https://tantalexlithium.com/tantalex-lithium-announces-start-of-commissioning-on-its-titan-tin-and-tantalum-plant/> (accessed: 28.11.2023)

## 6.3 Phalaborwa phosphogypsum REE project, South Africa

Information as of 02/2024

### 6.3.1 General project background

|                                 |                                                                                                                                                                                    |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | NdPr, Dy, Tb (NdPr represents 29 % of TREO)                                                                                                                                        |
| <b>Other commodities</b>        | Phosphogypsum, gypsum                                                                                                                                                              |
| <b>Location</b>                 | Limpopo Province, South Africa<br>23°59' S, 31°6' E, 375 m.a.s.l.                                                                                                                  |
| <b>License type</b>             | Reprocessing of residues of H <sub>3</sub> PO <sub>4</sub> production, mining right not required. Property rights are held by Rainbow Rare Earths.                                 |
| <b>License owner / operator</b> | Rainbow Rare Earths (85 % share with option for remaining 15 %)                                                                                                                    |
| <b>Contact</b>                  | Connaught House, St Julian's Avenue, St. Peter Port, Guernsey; Cathy Malins (Investor Relations)<br><a href="mailto:cathym@rainbowrareearths.com">cathym@rainbowrareearths.com</a> |
| <b>Project status</b>           | PEA completed in Oct 2022                                                                                                                                                          |
| <b>Production by 2030</b>       | Announced for 2026; feasibility study to be completed                                                                                                                              |



Figure 58. Phalaborwa project location, South Africa

### 6.3.2 Economic assessment

#### General project background:

The Phalaborwa Rare Earths project is located within the jurisdiction of the Ba-Phalaborwa Local Municipality in the Limpopo Province of South Africa and consists of two stacks with approximately 30 Mt of phosphogypsum, a residue from the neighbouring phosphoric acid production, which ended in 2014.

#### Project description:

|                                 |                                                                                                                     |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Ore deposit type                | Phosphogypsum stacks                                                                                                |
| JORC compliant resources        | 30.4 Mt at 0.44 % TREO (most recent update to 35.1 Mt, not yet independently confirmed as JORC-compliant)           |
| Share of global TREO reserves   | 0.1 % ( <i>USGS estimate global total REO (TREO) reserves of 130 Mt</i> )                                           |
| Waste to ore ratio              | Not yet available                                                                                                   |
| Annual production               | 1,848 t NdPr, Dy, Tb oxides                                                                                         |
| Life of mine                    | 14.2 years (~16 years based on resource update)                                                                     |
| Investment required             | CAPEX US\$ 295.5m (mainly processing plant)                                                                         |
| Net present value (NPV)         | US\$ 627m (post tax, 10 % discount rate)                                                                            |
| Share of global TREO production | 2.3 % ( <i>USGS estimates global TREO production of 280,000 t</i> )                                                 |
| Value addition potential        | Sale of phosphogypsum for use in the agricultural and construction industry; utilisation of existing infrastructure |

#### Mining and processing:

- No mining and concentrating related activities are necessary. The rare earths minerals (primarily apatite) contained in the phosphogypsum stacks have been chemically cracked by the historic phosphoric acid production process. This allows the operator to produce separated rare earths oxides in a single processing plant instead of producing a mineral concentrate, which requires crushing, milling and chemical cracking in a dedicated plant before feeding into a separation plant.
- Part of the existing disused phosphoric acid plant will be demolished or rehabilitated before the commencement of construction of the project. It is planned to use this rehabilitated area for the project in order to reduce investment costs and accelerate the project schedule by utilising the existing infrastructure as well as the permits already granted.
- 73 % of the total capital expenditure (US\$ 295.5m) is required for constructing the process plant. 56 % of the operational expenditure (US\$ 63.46m/a) is required for reagents, followed by 15 % for power. The operational expenditure per kg REO is US\$ 33.9. This is low compared to the given basket price of 137.9 US\$/kg of REO, leading to a payback period of only 2 years at an envisaged 14 years mine life (base case with a basket price of US\$/kg 137.92).

- TechMet, a U.S. government-backed critical minerals investment company, recently (12/2023) invested US\$ 50m in Rainbow Rare Earths. The separation of the rare earth oxides is planned at Rainbow's technical partner K-Technologies Inc. in Florida (currently being expanded to a pilot plant). According to the PEA, first production is scheduled for 2026.

### **BGR assessment and comments:**

- Phalaborwa is a low-grade and medium-tonnage project with a relatively high proportion of “magnet rare earths” (i.e. 29 % NdPr). In contrast to greenfield mining projects, the easily accessible ores of the stacks are an advantage and bear a low risk in terms of ore tonnage while reducing OPEX.
- The project is located in an established mining and industrial centre with appropriate infrastructure nearby (e.g., sulphuric acid plant) and on-site infrastructure (e.g., power line, roads, buildings). This can accelerate the start of the project as soon as all authorisations have been obtained.
- Rehabilitation of previously disturbed land could be performed during project development and financed from closure funding provided by the former owners of the property.
- The extraction of rare earths from phosphogypsum in general has proven technically, ecologically and economically challenging (initial investigations at Phalaborwa were carried out in the early 1980s). It has yet to be demonstrated whether the process flowsheet, which has so far only been tested on a laboratory scale with a recovery rate of 65-70 %, is scalable to industrial processing. The recovery of rare earths from apatite is not an established process. There are only a few similar projects (on an industrial scale on Kola peninsula in Russia and pilot projects in Estonia and Brazil) and therefore only limited experience with the extraction of rare earths from phosphate.
- Based on experience from other projects, marketing of gypsum as a by-product is unlikely. Although gypsum can usually be recovered relatively easily from tailings, large-scale use is currently not possible from an ecological and economic perspective due to technical requirements and health and environmental protection. Compared to other rare earths projects, the  $U_3O_8$  and  $ThO_2$  content is relatively low, but still too high for use in housing. Thus, it could rather be sold for road construction.



### 6.3.3 ESG assessment

As the project is still at an early stage, specific information on ESG practices is not yet available. An environmental impact assessment is underway and most of the information for the ESG assessment comes from the PEA. Waste reprocessing as planned for Phalaborwa has the potential, in addition to improving resource efficiency, to reduce the environmental impact of previous improperly sealed stacks (which have led to eutrophication of groundwater at the site) by depositing the material on a new stack in accordance with international best practice standards. The project will be built on an existing industrial site, so no new land is required. The remediation of some previously disturbed areas could be accelerated as part of the project.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Environmental management                                           | Environmental management is overseen by the Executive Board's Sustainability Committee and a sustainability report is published as part of the general Annual Report. An ESIA is currently ongoing and announced to be in accordance with the IFC Performance Standards.                                                                                                                                                                                                                                                                            |
| Efficient use of energy, renewable energy, GHG emissions reporting | Grid power supply by ESCOM, South Africa. The South African electricity grid is dominated by coal (around 70 % of installed electricity generation capacity). Energy intensive crushing and milling is not necessary. Disclosure of GHG emissions in accordance with the TCFD was announced and reporting to date is partially in line with TCFD reporting recommendations.                                                                                                                                                                         |
| Water management and consumption                                   | The project site is located in an area with high water stress. Groundwater below stacks has been contaminated through seepage water from unlined stack system. Polluted water from the existing stacks, ponds and from groundwater is to be neutralised and used as process water. Thus, the bulk of operational water requirements could be sourced from stack water. The design of stormwater containment facilities on site was considered in the PEA. A groundwater model was established 2016, but needs update. Water monitoring established. |
| Pollution prevention                                               | Unspecified soil contamination has occurred in the plant areas. This soil should be removed and safely disposed in the new lined gypsum residue storage facilities, which is announced to be constructed as part of the project. The polluted water in the ponds (low pH, heavy metals) is to be treated for instance with lime to prevent additional pollution of ground water and limit further eutrophication.                                                                                                                                   |
| Air quality                                                        | Information not available yet. The envisaged hydraulic reclamation will result in low dust pollution during operation. An air emissions licence is in place due to historical activities.                                                                                                                                                                                                                                                                                                                                                           |
| Tailings management                                                | Seepage of polluted water from the unlined existing stacks has been highlighted as a current problem and is to be eliminated. The phosphogypsum residue from the process will be placed on new lined stacks in accordance to IFC/Equator Principle. It is also recommended to refer to international best practice in relation to tailings management, such as the Global Industry Standard on Tailings Management.                                                                                                                                 |

| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Waste management                                          | Information not available yet.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Hazardous materials management                            | No detailed information available yet. Relatively low levels of radioactive elements (U 2 ppm, Th 47 ppm) compared to other rare earths projects.                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Noise and vibration                                       | Due to the absence of mining activities, noise and vibration is assumed to be at a relatively low level even though no information is available.                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Protected areas and biodiversity                          | Close to (~5 km) Kruger National Park. The southern part of the property is regularly visited by various animal species (giraffes, buffaloes, partly elephants). However, as the project is only of medium scale and is located in area with extensive historical mining activities, no additional impacts on biodiversity are expected. Positive biodiversity impacts might be targeted during closure.                                                                                                                                                                    |
| Mine closure                                              | Even if a detailed closure plan is not yet available, the rehabilitation of previously disturbed land could be accelerated during the project. Backfill material must be used to restore the terraces where the contaminated soils are removed (see above). A closure fund had been established by former owners, which is planned to be used. It is unclear what closure funds will be available for final closure of this project.                                                                                                                                        |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Community health, safety and security                     | The nearest settlements are the relatively large township of Namakgale (~1.5 km away, ~36,000 inhabitants) and the town of Phalaborwa (~4 km, ~13,000 inhabitants). The project will be constructed on an existing industrialised site and the risks (e.g., hazardous/radioactive material, impact on air and water quality, noise) to the health, safety and security of the local community are considered as low. Risks from existing stacks as groundwater contamination are rather expected to be reduced if the residues will be stored on new, better sealed stacks. |
| Dialogue and engagement with communities and stakeholders | The company is committed to stakeholder engagement as fundamental part of project development. A specific grievance mechanism for Phalaborwa is announced. Stakeholder consultations are planned for 2024 as part of the ongoing ESIA.                                                                                                                                                                                                                                                                                                                                      |
| Land acquisition and involuntary resettlement             | The project will be constructed on an existing industrialised site without further impacting land use or resettlement                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Occupational health & safety management                   | Commitment of Rainbow Rare Earths to a zero-harm working environment and to support employee health. No further information on OHS management available at this stage.                                                                                                                                                                                                                                                                                                                                                                                                      |
| Workers' rights                                           | South Africa scores 79/100 in the Labour Rights Index. No indication of non-compliance with fundamental workers' rights on the project site found. Commitment of Rainbow Rare Earths to responsible and fair employee practices.                                                                                                                                                                                                                                                                                                                                            |
| Gender and diversity                                      | Commitment to consider diversity and not to tolerate discrimination. The suppliers Code of Conduct explicitly addresses this topic.                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Local value added and community development               | Rainbow Rare Earths announced 300 direct job opportunities during the operation phase. According to the company, priority will be given to the people in the Ba-Phalaborwa area. The company announced to extensively                                                                                                                                                                                                                                                                                                                                                       |

| ESG category               | Assessment                                                                                                                                                                                                                                                                  |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | use local contractors in the construction and operation phase and specialised contractors mobilised from outside the Ba-Phalaborwa area will be encouraged to maximise local employment.                                                                                    |
| <b>Governance</b>          |                                                                                                                                                                                                                                                                             |
| Legal compliance           | Mining right not required. According to Rainbow Rare Earths, most of the existing general permits, licences and authorisations would apply to the project. However, there are no environmental authorisations yet that specifically authorise the processing of the stacks. |
| Management practices       | Management board with Sustainability Committee. Supplier Code of Conduct implemented. No details on implementation available at this stage.                                                                                                                                 |
| Transparency and reporting | Listed at London Stock Exchange. Transparent payment of taxes and royalties disclosed in Payments to Governments Report. Disclosure of GHG emissions in accordance with the TCFD has been announced. An Annual Report is available for 2022.                                |
| Business ethics            | South Africa scores 41/100 in the corruption perception index. It is not an EITI country. No indication of unethical practices found. General policies available include whistleblowing policy, anti-bribery, sustainability, code of conduct and supplier code of conduct. |

Table 80. ESG features of Phalaborwa project, South Africa

### 6.3.4 Further reading

Maja Mining Limited (2023): Bosveld Rare Earth Elements of the Phosphogypsum Stacks, Phalaborwa Mining Complex, South Africa – Mineral Resource Estimation Report, 1 July 2023.

[https://www.rainbowrareearths.com/wp-content/uploads/2023/08/RptMML2023\\_001-Rainbow-Bosveld-REE-MRE-FINAL-20230714.pdf](https://www.rainbowrareearths.com/wp-content/uploads/2023/08/RptMML2023_001-Rainbow-Bosveld-REE-MRE-FINAL-20230714.pdf) (accessed 13.02.2024).

Rainbow Rare Earths (2022a): Technical Report on the Phalaborwa Processing Flowsheet Development – August 2022. [https://www.rainbowrareearths.com/wp-content/uploads/2022/08/2022-08-23-Technical-Report-on-Phalaborwa-processing-flow-sheet-development\\_FINAL.pdf](https://www.rainbowrareearths.com/wp-content/uploads/2022/08/2022-08-23-Technical-Report-on-Phalaborwa-processing-flow-sheet-development_FINAL.pdf) (accessed 13.02.2024).

Rainbow Rare Earths (2022b): Preliminary Economic Assessment (PEA) – 30 September 2022. <https://www.rainbowrareearths.com/wp-content/uploads/2022/10/PHALABORWA-RARE-EARTHS-PROJECT-PEA-FINAL.pdf> (accessed 13.02.2024).

Rainbow Rare Earths (2023): A Strategic Source of Rare Earths Minerals for a Growing Market – Annual Report 2023 [https://www.rainbowrareearths.com/wp-content/uploads/2023/10/RRE-2023-Annual-Report\\_Final.pdf](https://www.rainbowrareearths.com/wp-content/uploads/2023/10/RRE-2023-Annual-Report_Final.pdf) (accessed 13.02.2024).

Rainbow Rare Earths (2024): Phalaborwa Site Visit – Presentation 31 January 2024.

<https://www.rainbowrareearths.com/wp-content/uploads/2024/01/Phalaborwa-site-visit-presentation-FINAL-website.pdf> (accessed 13.02.2024).



## 6.4 Tsumeb smelter Zn-Pb (-Ge-Ga) slag project (Namibia)

Information as of 02/2024

### 6.4.1 General project background

|                                 |                                                                                                                                                                                                                                                        |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary commodity</b>        | Zinc, lead                                                                                                                                                                                                                                             |
| <b>Other commodities</b>        | Germanium, gallium, copper, molybdenum                                                                                                                                                                                                                 |
| <b>Location</b>                 | Oshikoto, Namibia<br>19°14' S, 17°43' E, ~1,270 m.a.s.l.                                                                                                                                                                                               |
| <b>License type</b>             | Processing license for the Tsumeb Copper Smelter                                                                                                                                                                                                       |
| <b>License owner / operator</b> | 92 % Dundee Precious Metals Inc. (public company)<br>8 % Unnamed owner                                                                                                                                                                                 |
| <b>Contact</b>                  | 150 King Street West, Suite 902, P.O. Box 30<br>Toronto, Ontario, Canada<br><a href="http://www.dundeeprecious.com">www.dundeeprecious.com</a><br><a href="mailto:tsumebcommunications@dundeeprecious.com">tsumebcommunications@dundeeprecious.com</a> |
| <b>Project status</b>           | Active production of blister copper and sulphuric acid,<br>potential expansion and Zn-Ge-Ga extraction from slags                                                                                                                                      |
| <b>Production by 2030</b>       | Unlikely for reprocessing of gallium/germanium                                                                                                                                                                                                         |

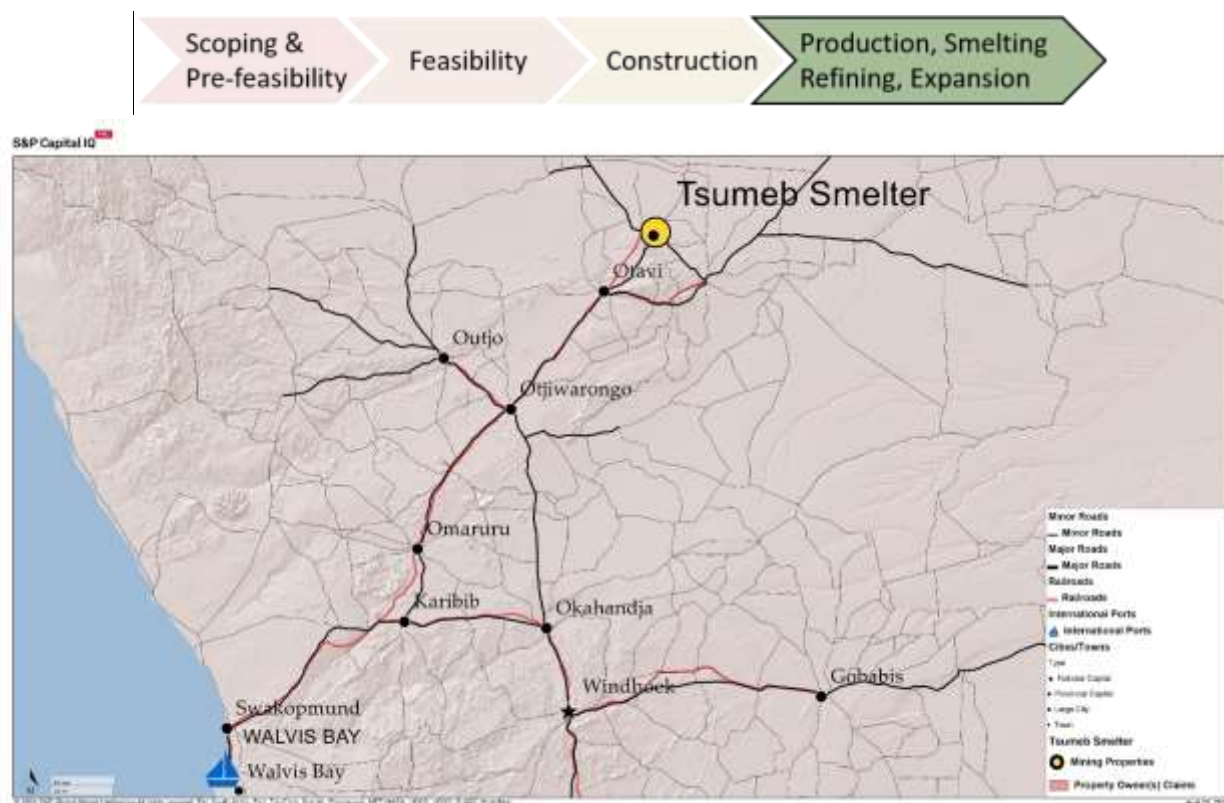


Figure 59. Tsumeb smelter location, Namibia

### 6.4.2 Economic assessment

#### General project background:

The Tsumeb smelter in Namibia is an active commercial-scale (max. 230,000 t concentrate/a throughput) copper smelter, run by Dundee Precious Metals Inc. (DPM) to process, among others, the complex (arsenic-bearing) copper concentrate from its Chelopech mine in Bulgaria. The smelter was built in the early 1960s. Between 1964 and 1998, smelting of copper and lead concentrates from the Tsumeb mine took place, with additional concentrate feed from other countries in Africa and globally. Smelting resulted in large quantities of slag enriched in germanium, gallium, arsenic, molybdenum, lead and zinc. This enrichment represents a resource of its own that has been the focus of several scientific publications for over two decades. Currently, DPM is about to complete a JORC-compliant Mineral Resource Estimate. DPM's interest in processing the slags is to gain additional revenue and possible synergy effects with the current smelter, but also to clean up the smelting residues (the slag is contaminated with arsenic, lead and other metals) and to create job opportunities.

#### Project description:

|                                           |                                                                                                                                                  |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Mineral resource type                     | Residual slags from copper and lead/zinc smelter                                                                                                 |
| Current resources<br>(non-JORC compliant) | 2.2 Mt @ 183 g/t Ge, 200 g/t Ga, 9 % Zn                                                                                                          |
| Share of global germanium resources       | as of USGS: <i>Data on the recoverable germanium content, especially of zinc ores, are not available</i>                                         |
| Share of global gallium resources         | 0,44 % (considering 440 t contained Ga)<br><i>(USGS estimate global bauxite-hosted Ga resources of 100,000 t considering a recovery of 10 %)</i> |
| Processing type                           | Pyrometallurgical fuming and/or hydrometallurgical process<br>(considered)                                                                       |
| Waste to ore ratio                        | Slag without cover; waste to ore not applicable                                                                                                  |
| Offtake agreements                        | Interest to enter negotiations                                                                                                                   |
| Investment required                       | US\$ 47-55m for Cu smelter expansion to 370,000 t. Quantity for Zn, Ge, Ga slag reprocessing not defined yet.                                    |
| Net present value (NPV)                   | Not defined                                                                                                                                      |
| Value addition potential                  | Value addition to Ga, Ge, Cu, Pb, Mo and Zn metal already high; slags to be cleaned for construction purposes                                    |

#### Processing:

- Currently, the facility consists of a primary smelting furnace, the Ausmelt furnace, two Peirce Smith Converters, bag houses and cooling towers, a slag milling plant, two high voltage distribution sub-stations, a materials handling facility, two oxygen plants, a fume extraction system, arsenic separation and deposition, and a sulphuric acid plant.
- The slag is currently in the form of milled/granulated slags and a few massive fragments. Gallium is predominantly hosted in Zn-Fe-Al spinels, which form crystals with a size of less than



10 µm and are surrounded by a silicate matrix. Germanium is mostly bound in silicate glass, which volumetrically accounts for a large part of the granulated slags, but is also contained to a lesser extent in other silicates (melilite and olivine group phases). The highly variable germanium and gallium concentrations indicate that strict grade control would be needed to optimise recoveries. Furthermore, laboratory attempts aimed at extracting germanium from the Tsumeb slags showed that ultrafine milling is required to liberate gallium in parallel before the potential extraction and recovery of germanium and gallium can proceed.

- Sulphuric acid is a by-product from copper concentrate smelting (~200,000 t/a). However, sulphuric acid leaching is not considered in the extraction of germanium and gallium, because this process is usually difficult on an industrial scale due to the issues of silica gel formation and high acid consumption. In contrast, DPM currently proposes pyrometallurgical fuming as an extraction process (Sustainability Report 2022).

#### **BGR assessment and comments:**

- DPM is currently carrying out a mineral resource estimate and has drilled and extensively surveyed the tailings over the last two years. Most of the samples have been analysed. Initial results already confirm the literature data.
- More experimental work is needed to understand the optimum conditions for comminution of the slags (Ettler et al., 2020 and references therein), extraction, and recovery of Ga and Ge and other elements from these materials.
- The business case with pyrometallurgical fuming is not very attractive at current metal prices, especially because a smelter and hydro plant are required for a mine life of 10-15 years. This capacity utilisation could be achieved through synergies with similar Ge-resources, such as the slags from Kipushi (DRC), if they were available.
- Strong risk of not identifying a financially viable reprocessing flow sheet. But also relatively low costs for further studies at the moment.
- The Tsumeb Smelter is located approximately 430 km north of the capital city of Windhoek and is connected by rail to the Atlantic port of Walvis Bay. Tsumeb is the closest town to the Etosha National Park and has a population of 45,000 people. The smelter facility is connected to the national power grid. The Tsumeb smelter employs approximately 800 people. An expansion towards slag processing would create new jobs that could be staffed with local skilled and unskilled personnel from Namibia's mining sector.

### 6.4.3 ESG assessment

Although the project is about slag reprocessing, this ESG part will deal with the Tsumeb copper smelter. The reason is that it is impossible to separate the reprocessing from the current operation, as it will most likely not be a completely new facility, if it comes to slag reprocessing. Although DPM has taken several efforts to improve the Tsumeb smelter, it is not considered to be of European standard in terms of emissions. There will be diffuse emissions during smelting and converting of unknown impact. As the reprocessing project seeks to restart an inactive mining residue, overall additional risks of negative increased negative impacts are considerably low. Starting slag processing actually holds the opportunity of recreating jobs in the community as well as recultivation of sites.

| ESG category                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Environment</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Environmental Management                                           | Comprehensive environmental management information on general company website. The northern area of Tsumeb is significantly contaminated. Especially the soil due to over a century of historic emissions from industrial-scale mining and smelting, augmented by spillages and wind erosion of tailings, slags and other wastes. The contaminants include a range of metalloids, metals and salts. Clean-up and rehabilitation measures include both physical removal of spillages and eroded wastes, and a range of phytotechnologies (i.e., plant and microbe-based technologies). |
| Efficient use of energy, renewable energy, GHG emissions reporting | Supply from grid, imports the majority of its electricity from South Africa; Namibia's as well as South Africa's grid has a high fossil energy share. In 2022 DPM signed a 5-year Power Purchase Agreement (starting 2024) for the Tsumeb smelter with a solar power plant in Namibia. The consumption of renewable energy shall cover approximately 30% of total electricity consumption at the smelter (sustainability report 2022).                                                                                                                                                |
| Water management and consumption                                   | Project site in arid area with low water use. Risk of extreme rainfall and overflow identified by company. Stormwater channels are under renovation. The Tsumeb smelter abstracts 1.83 Mm <sup>3</sup> per year and the municipality of Tsumeb 1.67 Mm <sup>3</sup> per year. The water is mostly taken from the old mine shaft in 235-250 m depth. No drop of groundwater level in observation wells is observed. The water need for a reprocessing facility using pyrometallurgical fuming is unknown.                                                                              |
| Pollution prevention                                               | Off-gas cleaning crucial, when applying pyrometallurgical fuming. Regents and liquid control, prevention of spills crucial, when applying hydrometallurgical process.                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Air quality                                                        | The long-lasting smelting operation caused severe pollution in the past. The new off-gas handling and SO <sub>2</sub> removal is causing far less harm to the environment: SO <sub>2</sub> reduction of 95 % and 72 % reduction of As <sub>2</sub> O <sub>3</sub> . Nevertheless, there is still potential to increase off gas handling and emissions. The pyrometallurgical reprocessing of the slag might cause                                                                                                                                                                     |



| ESG category                                              | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | heavy metal contaminated off-gases that have to be handled to avoid further contamination.                                                                                                                                                                                                                                                                                                                                                                                                     |
| Tailings management                                       | No information on tailings management available. Tailings and slag deposition standards unknown.                                                                                                                                                                                                                                                                                                                                                                                               |
| Waste management                                          | DPM has a waste hierarchy in place. Segregate waste streams into mineral and non-mineral waste. Mineral waste is further categorized into three different streams: mill tailings, mined waste rock, and hazardous mineral waste (including arsenic waste.) Non-mineral waste includes other waste such as metals, oils, plastics and construction materials.                                                                                                                                   |
| Hazardous materials management                            | DPM states that handling of arsenic is focus area of waste management in Tsumeb and has an Arsenic Exposure Reduction Plan for continuous improvement and to ensure compliance with both international and national standards. Reduction in percentage or concrete measures are unknown. According to DPM they are meeting the requirements for long term storage of such types of materials by building a hazardous waste landfill facility as an engineered solution.                        |
| Noise and vibration                                       | No special measures needed at the Tsumeb smelter, as it is no mine site. No increase to current noise level at the smelter is expected by the reprocessing project.                                                                                                                                                                                                                                                                                                                            |
| Protected areas and biodiversity                          | The project is not located in or close to a key biodiversity area or other designated protected area. Project site is a historical smelting area; expected biodiversity impacts are low.                                                                                                                                                                                                                                                                                                       |
| Mine closure                                              | The site has an operation with an indefinite life and, as such, is not under a strict requirement for a formal closure plan. Nevertheless, DPM states that long-term management of the surrounding environment is a priority, and that they have ecological and ecosystem research programs in progress, with the goal of ensuring the long-term viability of local ecosystems. The closure of the smelter would require huge efforts to clean up pollution from decades of smelting residues. |
| <b>Social and socio-economic issues</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Community health, safety and security                     | No particular information about the Tsumeb smelter available. The slag project site is directly at a current smelting operation.                                                                                                                                                                                                                                                                                                                                                               |
| Dialogue and engagement with communities and stakeholders | DPM reports that it has a community investment development plan for each of its sites; funds are allocated based on an assessment of the needs of the community, and with a plan to support its long-term sustainable Development; the plan is developed in collaboration and consultation with community stakeholders. Opposition to slag reprocessing unlikely, as no new impact, but reprocessing of old mining residues.                                                                   |
| Land acquisition and involuntary resettlement             | The smelting facility has been in place for decades. No known incidences. For the reclamation of the historic slag no significant impacts are anticipated.                                                                                                                                                                                                                                                                                                                                     |
| Occupational health & safety management                   | DPM states that they tested an approach to use machine vision technology to support employees' compliance with health and safety practices to increase safety at the Tsumeb smelter.                                                                                                                                                                                                                                                                                                           |

| ESG category                                | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | DPM reported that they missed their safety target and saw an increase in the Total Recordable Injury Frequency Rate, causing the company to reflect on their established systems and safety culture, to identify gaps and apply remedies, started a 'Safety Reset' Campaign in Tsumeb that consisted of one-on-one engagement sessions, infield training and coaching, risk identification and management.                                                                                                                                                                      |
| Workers' rights                             | Namibia scores 68.5/100 in the Labour Rights Index (limited access to decent work). No indication of non-compliance with fundamental workers' rights on the project site found.                                                                                                                                                                                                                                                                                                                                                                                                 |
| Gender and diversity                        | DPM states that they almost achieved gender parity with 45% female representation amongst senior management levels across the whole company.                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Local value added and community development | Supporting local schools (e.g., solar power system to the Emany Primary School, IT infrastructure). Support to community health and wellness. 3-year community investment agreement with the Oshikoto Regional Council and Tsumeb Municipality (167,000 US\$). Reprocessing of slag holds the opportunity of creating jobs in the community; established the Tsumeb Community Trust; Tsumeb operation is an Export Processing Zone (EPZ) therefore exempt from corporate income taxes in Namibia. DMP publishes payments under the Extractive Sector Transparency Measures Act. |
| <b>Governance</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Legal compliance                            | No outstanding permitting issues known/relevant, as it is an on-site slag deposit, already owned by DPM.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Management practices                        | DPM is committed to a code of business conduct and ethics and has relevant policies in place including risk management, supply chain management; it was included in the S&P Global Sustainability Yearbook 2023, which features companies that scored in the top 15% of their industry; received an "A" rating from MSCI ESG Research LLC.                                                                                                                                                                                                                                      |
| Transparency and reporting                  | Listed on the TSX; comprehensive reporting; Sustainability reporting follows the GRI standards, the SASB industry-specific standards, the TCFD framework; Bureau Veritas UK Ltd. has provided independent limited assurance of the data reported in the sustainability report 2022.                                                                                                                                                                                                                                                                                             |
| Business ethics                             | Namibia scores 49/100 in the corruption perception index (rank 59/180); Namibia is not an EITI country, but DPM states to report under international initiatives such as the EITI and the Canadian Extractive Sector Transparency Measures Act (ESTMA) regulation; no indication of unethical practices found.                                                                                                                                                                                                                                                                  |

Table 81. ESG features of Tsumeb slag project, Namibia

#### 6.4.4 Infrastructure assessment

##### Potential Investment Needs:

- Renewable Energy Ventures: Business opportunity in the construction of renewable energy power stations (e.g., solar and biomass).
- Water Supply: Construction of additional infrastructure to manage contact water around the smelter expansion site to monitor pollution levels.

| Infrastructure Assessment |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site specific             | The smelter is located in Tsumeb, the largest town in the Oshikoto region. It is situated adjacent to the residential area, which offers daily services. It is approx. 5 km away from the central town area, 7.5 km away from Tsumeb domestic airport, and 102 km SW of Etosha National Park.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Transport                 | The B1 national road connects Tsumeb to the west and south, C41 to the east and M75 to the north. A 1,600 km development corridor, the Trans-Cunene corridor road, connecting Namibia (Walvis Bay) and Angola (Lubango) runs directly through Tsumeb and ensures connection to Walvis Bay port.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Airport                   | There is one domestic airport in Tsumeb, namely the Tsumeb Airport (Aeroputal Tsumeb), that can be utilized for transportation of equipment or personnel. The use of the road is suggested for machine or plant components.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Rail access               | The project is directly connected to a TransNamib railway that follows the roads B1, C33, B2 to Swakopmund and from there to Walvis Bay. This railway merges in Otavi with the extension of the Trans-Caprivi Railway Corridor, which connects the Port of Walvis Bay and Katima Mulilo, passing Grootfontein 65 km SE of Tsumeb. This railway is used to transport material to the port of Walvis Bay.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Port                      | Tsumeb is located inland, around 600 km from Walvis Bay, the next suitable port. Generally, Walvis Bay, a secured and congestion-free shallow seaport, can be accessed via the B1 to C33 and B1 to C39 routes. It can handle bulk, containerized, frozen, and dry cargo. Current container capacity ranges from 400,000 TEUs to 750,000 TEUs annually. Managed jointly by the public-private partnership Walvis Bay Corridor Group (WBCG) and Namport, this port facilitates trade for regions like Namibia, Zambia, the Democratic Republic of Congo, and Botswana. Contracts with China Harbour Engineering Company Ltd. for extension are in place. Plans for its development intend to further bolster the existing trade corridors (road and rail) improving also the mining sector. With a depth ranging from 12.8 to 16 m, it is specialized in accommodating handy-size ships possessing a maximum length of 192 m and draft of 10 m with 15,000 to 35,000 dwt. A floating dry dock has been added that can lift vessels up to 150 m in length with a 25-m beam and displace 8,500 t. The port features offload and onload facilities including electric rail-mounted wharf cranes, mechanical appliances, and rail track lifting capabilities. Storage facilities comprise two cargo sheds that offer 7,900 m <sup>2</sup> , while raised ore platforms cover 5,708 m <sup>2</sup> . Additionally, two ore bins total over 11,000 m <sup>2</sup> , with one having a conveyor loader. A privately operated cold storage provides 15,000 m <sup>3</sup> , and there's 30,000 m <sup>2</sup> available for 'rough' goods storage. The majority of goods arrive by truck (90 %), followed by train (10 %). |
| Energy                    | A substation near Tsumeb is supplied with high voltage powerlines between 132 kV – 220 kV that provides sufficient energy. NamPower is working on the construction of the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | 40 MW Otjikoto Biomass Power Station in close proximity to the township of Tsumeb. The project will harvest encroacher bush extending beyond a 100 km radius from the plant site and is expected to operate over a 25 year lifespan.                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| GHG emission | Main pollution is resulting from SO <sub>2</sub> . After commissioning of the sulphuric acid plant in 2015, ambient air quality monitoring stations have reported significant downward trends in SO <sub>2</sub> emissions of 95 % from 2014 to 2021. Namibia is abundantly endowed with diverse renewable energy sources. The country boasts the world's second highest solar and wind regimes, of which the former is more relevant to the project site. In addition, Namibia has a large capacity of rangeland and biodiversity which make it suitable for the accumulated biomass opportunities from bush thinning, making it an economically viable resource for value addition opportunities. |
| Water        | DPM uses closed loop cooling water circuits. Raw water is pumped from the old mine shafts as there are no natural surface water sources within the smelter property. Beside raw water out of shafts, the planned improved stormwater management measures include a non-contact water diversion channel around the northern edge of the main smelter site in order to channel clean run-off away from the smelter site and to the Jordan River. This measure will improve the runoff from the site, as less water will flow into the smelter area and be retained in the contact water system at the site.                                                                                           |

**Table 82. Infrastructure assessment of Tsumeb slag project, Namibia**

#### 6.4.5 Further reading

Dundee Precious Metals (2018): Tsumeb Smelter: 3D Groundwater flow and contaminant transport. [https://cdn.slrconsulting.com/uploads/2020-06/DPMT\\_AppendixE\\_Groundwater\\_Addendum\\_Part1.pdf](https://cdn.slrconsulting.com/uploads/2020-06/DPMT_AppendixE_Groundwater_Addendum_Part1.pdf)

Dundee Precious Metals (2022): Fourth Quarter Report. Management's Discussion and Analysis of Consolidated Financial Condition and Results of Operations for the Three and Twelve Months Ended December 31, 2022. (accessed 27.06.2023)

Dundee – Precious Metals (2024). Tsumeb Specialty Smelter, Namibia. (assessed 11.03.2024). <https://dundeeprecious.com/assets/other/tsumeb-specialty-smelter/>

Ettler V, Mihaljevič M, Strnad L, Jedlicka, R, Kříbek B, Howell R.J., Kamona F, Mapani B,. (2021) Mineralogy of Ga- and Ge-bearing metallurgical slags from Tsumeb, Namibia. Mineralogical Magazine. 2021;85(6):879-889. doi:10.1180/mgm.2021.83

Melcher F, Buchholz P. (2012) Current and Future Germanium Availability from Primary Sources. Minor Metals Conference, Cologne, 24 April 2012. [https://www.bgr.bund.de/DERA/DE/Downloads/vortrag\\_germanium.pdf](https://www.bgr.bund.de/DERA/DE/Downloads/vortrag_germanium.pdf).

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[https://s27.q4cdn.com/486073686/files/doc\\_documents/EN/DPMT\\_Draft\\_ESIA\\_Exec\\_Summ\\_Apr17.pdf](https://s27.q4cdn.com/486073686/files/doc_documents/EN/DPMT_Draft_ESIA_Exec_Summ_Apr17.pdf)

SLR Environmental Consulting (Namibia) (Pty) Ltd, 2019. ESIA amendment process for the proposed Tsumeb expansion projects – Final ESIA Report. (assessed 11.03.2024).

[https://cdn.slrconsulting.com/uploads/2020-06/DPMT\\_Final\\_ESIA\\_July19.pdf](https://cdn.slrconsulting.com/uploads/2020-06/DPMT_Final_ESIA_July19.pdf)



## 7 Infrastructure clusters

Infrastructure bottlenecks are one of the main growth constraints for the African mining sector. Infrastructure deficits often do not only apply at single mine locations but rather reflect broader challenges that need to be addressed at a regional scale in current or prospective mining regions. Infrastructure development may also attract exploration to regions that are underexplored. Based on the methods described in chapter 2.3, 21 regional infrastructure clusters were identified all across Africa. Their locations are shown in the following figure.

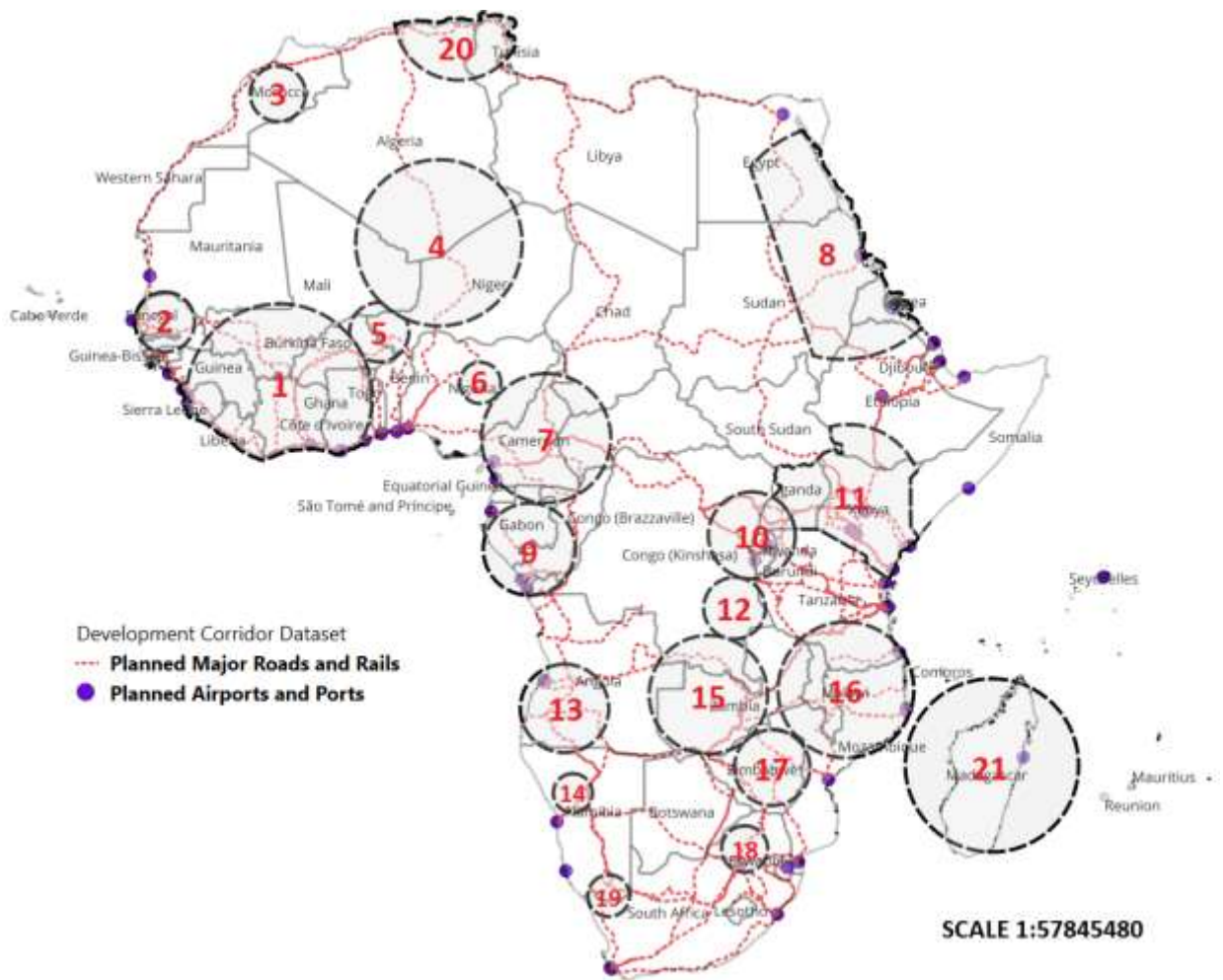


**Figure 60. Location of the 21 conceptual infrastructure clusters assessed in this study.**

Investment needs for further infrastructure development are identified in order to build and support a sustainable EU-Africa mineral supply chain. Interactions between the clusters are identified to potentially combine future infrastructure development projects across the borders of clusters. This further facilitates efficient ECRM exploration and exploitation. A summary of ECRM and investment needs associated with all clusters is provided in the following table.

| Cluster ID | Region / name of ID                  | Quantitative assumption of predominant ECRM occurrences                                                    | Investment needs                                        | Cluster interactions |
|------------|--------------------------------------|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|----------------------|
| 1          | West African Coast (WAC)             | Aluminium, Copper, Graphite, Lithium, Manganese, Nickel, Tin, Titanium, Tungsten, Cobalt, Niobium-Tantalum | Mining, Processing, Rail, Ports, Energy, Communications | 2, 4, 5              |
| 2          | Senegal                              | Phosphates                                                                                                 | Mining, Processing, Road, Rail, Energy, Communications  | 1                    |
| 3          | Morocco                              | Copper, Cobalt, Manganese, Tin, Tungsten, Phosphates                                                       | Mining, Processing, Road, Rail, Ports, Energy           | -                    |
| 4          | Northern and Western Africa (Inland) | Copper, Fluorite, Phosphates, Tin, Tungsten                                                                | Mining, Processing, Road, Energy, Communications        | 1, 5                 |
| 5          | Western Africa (Inland)              | Copper, Graphite, Manganese, Tin, Phosphates                                                               | Mining, Processing, Road, Rail, Energy, Communications  | 1, 2, 4              |
| 6          | Nigeria                              | Tin, Niobium-Tantalum                                                                                      | Mining, Processing, Road, Energy, Communications        | 7                    |
| 7          | Western and Central Africa           | Aluminium, Copper, Niobium-Tantalum, Tin, Titanium, Tungsten                                               | Mining, Processing, Road, Energy, Communications        | 6, 9                 |
| 8          | Coast of Red Sea                     | Copper, Manganese, Tin, Tungsten, Phosphates                                                               | Mining, Processing, Road, Energy, Communications        | -                    |
| 9          | Central African Coast (West)         | Aluminium, Copper, Niobium-Tantalum, Manganese, Tin, Tungsten, Phosphates                                  | Mining, Processing, Road, Rail, Energy, Communications  | 7                    |
| 10         | Central and Eastern Africa           | Copper, Niobium-Tantalum, Lithium, Tin, Tungsten                                                           | Mining, Processing, Road, Rail, Energy, Communications  | 11, 12, 16           |
| 11         | Eastern Africa (North)               | Copper, Graphite, Niobium-Tantalum, Lithium, Manganese, Nickel, Fluorite                                   | Mining, Processing, Rail, Airports,                     | 10                   |

| Cluster ID | Region / name of ID                | Quantitative assumption of predominant ECRM occurrences                                                                  | Investment needs                                                 | Cluster interactions   |
|------------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|------------------------|
|            |                                    |                                                                                                                          | Energy, Communication                                            |                        |
| 12         | Central- & Southern-Africa         | Copper, Niobium-Tantalum, Tin                                                                                            | Mining, Processing, Road, Rail, Airports, Energy, Communication  | 10, 11, 15, 16         |
| 13         | Angola                             | Copper, Manganese, Nickel, Titanium, Fluorite                                                                            | Mining, Processing, Road, Rail, Energy, Communication            | 14, 15                 |
| 14         | Namibia                            | Copper, Graphite, Lithium, Tin, Tungsten, Fluorite                                                                       | Mining, Processing, Road, Rail, Energy                           | 13, 15, 19             |
| 15         | Central and Eastern Africa (South) | Copper, Cobalt, Manganese, Tin                                                                                           | Mining, Processing, Road, Energy, Communications                 | 10, 12, 13, 14, 16, 17 |
| 16         | Eastern Africa (South)             | Aluminium, Copper, Graphite, Niobium-Tantalum, Nickel, Titanium, Fluorite, Phosphates                                    | Mining, Processing, Road, Rail, Energy, Communications           | 10, 12, 15, 17         |
| 17         | Zimbabwe                           | Copper, Lithium, Nickel, Tin, Tungsten                                                                                   | Mining, Processing, Road, Rail, Energy                           | 15, 16, 18             |
| 18         | South Africa (North)               | Tin, Fluorite, Platinum Group Elements                                                                                   | Mining, Processing, Rail, Energy                                 | 17                     |
| 19         | South African Coast (West)         | Copper, Tungsten, Fluorite                                                                                               | Mining, Processing, Road, Rail, Airports, Energy, Communications | 14                     |
| 20         | North African Coast                | Phosphates, Copper                                                                                                       | Mining, Processing, Road, Port                                   | -                      |
| 21         | Madagascar                         | Copper, Graphite, Niobium-Tantalum, Lithium, Manganese, Nickel, Tin, Titanium, Tungsten, Fluorite, Phosphates, Aluminium | Mining, Processing, Road, Shipping, Rail, Energy, Communication  | -                      |

Table 83. Overview on infrastructure clusters, associated ECRM and investment needs

## 7.1 Cluster 1: West African Coast (WAC)

|                                                      |                                                                                                            |
|------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X -6,210880, Y 9,947441                                                                                    |
| Area estimated                                       | 1,570,000 km <sup>2</sup>                                                                                  |
| Predominant ECRM occurrences (prospecting – deposit) | Aluminium, Copper, Graphite, Lithium, Manganese, Nickel, Tin, Titanium, Tungsten, Cobalt, Niobium-Tantalum |
| Country coverage                                     | Ghana, Burkina Faso, Côte d'Ivoire, Liberia, Sierra Leone, Guinea, Mali                                    |

### 7.1.1 Location

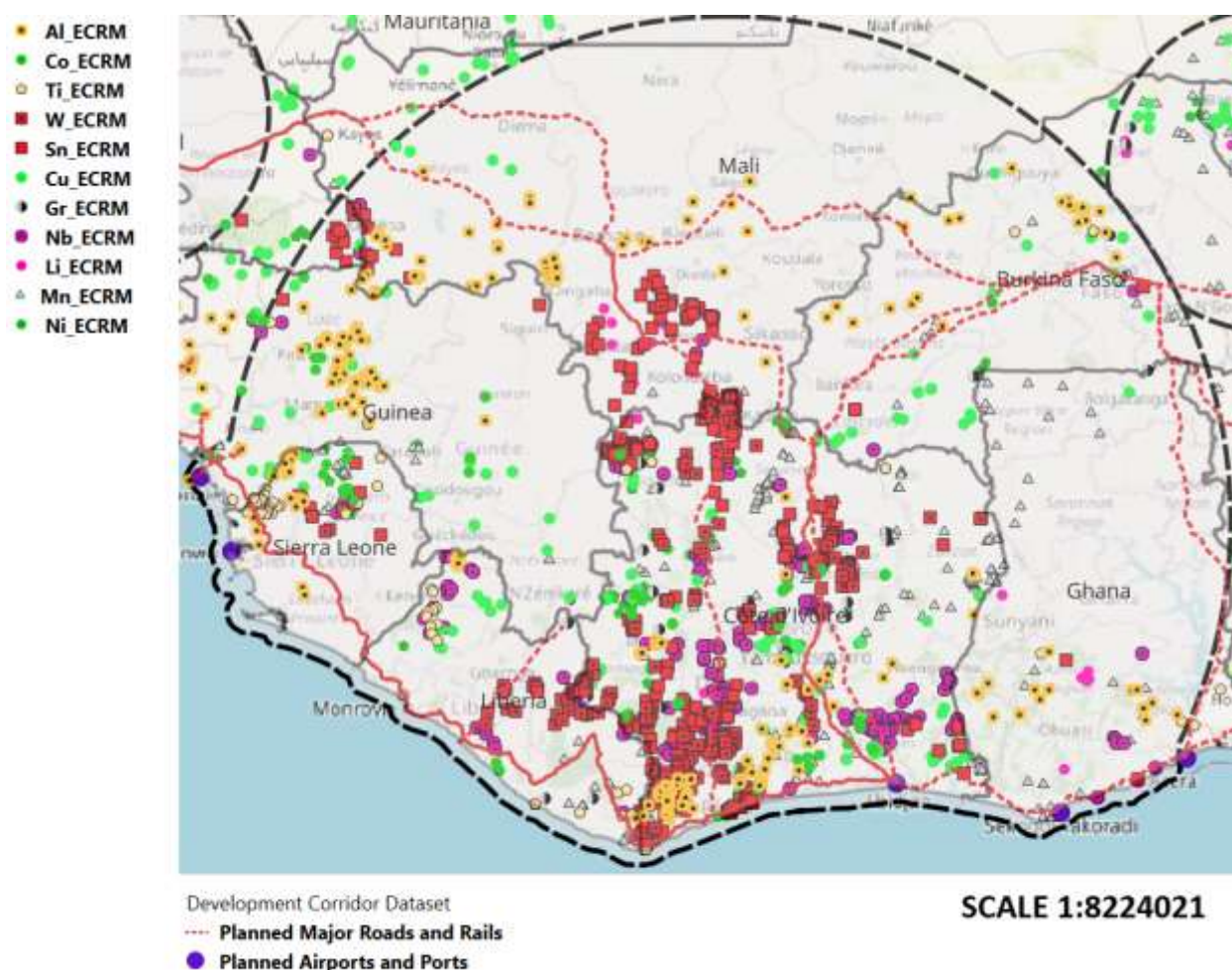


Figure 61 Location of Cluster 1: West African Coast (WAC)

### 7.1.2 Summary

Cluster 1 is rich of highly sought after ECRMs, of which bauxite is especially predominant. Encapsulated countries are politically stable at the coast, becoming less stable to the inland. ASM of gold and/or diamonds plays a crucial role in Côte d'Ivoire and Liberia, while the ASM 3T sector

is only small, but could be considered during development projects. Due to the dense ECRM occurrences, exploration projects, mining operations, and processing facilities exist, however could be further developed to fully grasp the ECRM potential. Take-off investments can especially be made in ECRM exploration projects to help them reach production, as well as to strategically develop processing facilities as a hub to support exploitation of similar ECRM occurrences in one region. Road and shipping infrastructure is adequately developed, whereas investments are necessary to expand the cross-border rail infrastructure, especially between capital cities and the sea. Beside minor sea freight development needs in Côte d'Ivoire, port infrastructure at the coast is sufficient. Investments in energy distribution are needed to develop medium and high-power lines in Liberia, Sierra Leone, and Côte d'Ivoire. Adequate communication is provided by the Africa Coast to Europe (ACE) submarine fibre-optic network. Nevertheless, investments can be made in Ghana, Liberia, and Sierra Leone to improve mobile network in remote areas. Synergies are identified with the work of the Development Corridors Partnership (Tanzania, Kenya, China, and the UK) that funded multiple projects within this cluster until 2021. Thereafter, the EU in cooperation with the African Development Bank has committed to funding projects until 2024. Cross-border development projects may be connected with potential projects in clusters 2, 4, and 5.

### 7.1.3 Assessment

**Main investment needs:** mining, processing, rail, ports, energy, communications.

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in Ghana, Sierra Leone, Liberia, Côte d'Ivoire, and Guinea, moderate in Burkina Faso, and high in Mali. With respect to the African continent, Ghana is ranked 13 <sup>th</sup> , Sierra Leone 14 <sup>th</sup> , Liberia 21 <sup>st</sup> , Côte d'Ivoire 27 <sup>th</sup> , Guinea 35 <sup>th</sup> , Burkina Faso 45 <sup>th</sup> , and Mali 52 <sup>nd</sup> of the 53-country dataset as of 2022. |
| Artisanal Small-Scale Mining | Relevant ASM producer countries for ECRM in Cluster 1 are Côte d'Ivoire and Liberia. ECRMs exploited via ASM practices include mainly tantalum-niobium (coltan) beside non-ECRMs gold and diamonds.                                                                                                                                                                                                                                                                                                                                                                 |
| Mining                       | Mining facilities are in every country of the cluster, focusing on gold, lead, silver, zinc, manganese, bauxite, diamond, iron ore, titanium, and zirconium. Investments can be made to support ECRM exploration projects turning operational.                                                                                                                                                                                                                                                                                                                      |



|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Processing facilities          | Few processing facilities are found in Liberia, Côte d'Ivoire, Ghana, Sierra Leone, and Guinea, specialising in manganese (predominantly), baryte, cement, diamond, gold, alumina, phosphate, petroleum. Investments can be made in processing facilities to exploit the vast ECRM occurrences, with strategic locations near planned or active development corridors, e.g., east-west corridors Dakar-Lagos (Senegal-Nigeria).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Road / shipping infrastructure | <p>Road infrastructure sufficiently connects the region. Trunk roads (highways) connect the capital cities Conakry (Guinea), Freetown (Sierra Leone), Monrovia (Liberia), Yamoussoukro (Côte d'Ivoire), Accra (Ghana), Ouagadougou (Burkina Faso), and Bamako (Mali) with each other. Material can be transported via highways to the ports for sea traffic. ECRM occurrences, mines, and processing facilities are well connected to primary (national), secondary (regional) roads, and local gravel roads, that can be used for material transportation.</p> <p>The rivers Bakoye and Baouté (Mali), Niger and Bafing (Mali, Guinea), as well as the Volta River system (Ghana, Burkina Faso) could be used for inland shipping of equipment/personnel or to transport material (estimated small quantities of material) to the coast, Lake Volta (Ghana) or Saint-Louis (Senegal).</p> <p>Road infrastructure of planned or active development corridors, funded by the African Development Bank and partly supported by EU grants can be used for material transport, e.g., Accra-Ouagadougou north-south corridor (Ghana-Burkina Faso). Most of the projects are planned to be finalized in 2024. Investments per corridor, including co-funding, are estimated to be below € 100m.</p> |
| Rail infrastructure            | <p>Rail infrastructure is limited. Two major railways connect the inland with the sea; Ouagadougou (Burkina Faso) with Abidjan (Côte d'Ivoire) (development corridor), and Bamako (Mali) with Dakar (Senegal). Few inner-country connections connect towns with the following port facilities on the coast: Conakry and Kamsar (Guinea), Freetown (Sierra Leone), Monrovia and Buchanan (Liberia) as well as Sekondi-Takoradi (Ghana). Connecting Yamoussoukro (Côte d'Ivoire) with Harper (Liberia) may be a lucrative investment opportunity, due to the high density of ECRM occurrences. This segment intersects Parc National de Tai (Côte d'Ivoire) and would therefore be subject to environmental review.</p> <p>Rail infrastructure of proposed and active development corridors can be used, e.g., Abidjan-Ouagadougou (Côte d'Ivoire-Burkina Faso).</p>                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Airports                       | Beside international airports in the capital cities, numerous regional inland airports exist that can be used to transport material or persons. As most of the capital cities are located by the sea, material can be transported to the international airports for export by ship or plane. Imported materials can be locally re-directed by rail or road infrastructure.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ports         | Port infrastructure is adequate to transport products via sea. Conakry has a general cargo port and Kamsar a bulk commodity port (Guinea). Pepel, Freetown, and Bonthe (Sierra Leone), Monrovia and Buchanan (Liberia), as well as Sekondi-Takoradi (Ghana) have general bulk commodity ports. Abidjan is the only cargo port of Côte d'Ivoire. Investments can be made in Côte d'Ivoire, e.g., at San-Pédro, to support sea freight as it is the richest country regarding ECRM occurrence. Investment opportunity may be coupled with the Harper (Liberia) – Yamoussoukro (Côte d'Ivoire) rail proposal to establish a port in Harper.                                                                                                                                                                                                                          |
| Energy        | Power stations with generation capacities ranging between 100-1000 MW are located at the seaside and near capital cities. Despite a few power stations below 10 MW, there is a major lack of inland power stations between 10-100 MW, especially in the border region of Liberia, Guinea, and Côte d'Ivoire. Ghana has the only extra high voltage (330 kV – 765 kV) power line connecting Bolgatanga and Sekondi-Takoradi, as well as Sekondi-Takoradi with the western coastline. The distribution of energy is mostly done via medium (33 kV – 110 kV) to high (110 kV - 275 kV) voltage power lines. Investments can be made in the distribution of energy via power lines in Liberia and Sierra Leone in border regions as well as in the North (border to Mali) and South (west of San Pédro, border to Liberia) of Côte d'Ivoire to supply ECRM hot spots. |
| Communication | The Africa Coast to Europe (ACE) 17,000 km cable system, led by MTN (Pty) in South Africa, puts into commercial service the linkage of Europe, West African capital cities, and South Africa in June 2021. This system increases design capacity of the entire system to 20 Tbps, capable of offering 100 Gbps connections. Significant mobile network providers are MTN, Orange Mobile, Moov African Mobile, Malitel Mobile, Africell Mobile, and Telecel Mobile, delivering up to 4G+. However, development is needed to improve mobile network coverage in remote areas not connected to major roads or cities in Ghana, Liberia, and Sierra Leone.                                                                                                                                                                                                            |

Table 84 Infrastructure assessment of Cluster 1: West African Coast (WAC)

## 7.2 Cluster 2: Senegal

|                                                      |                           |
|------------------------------------------------------|---------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X -14,949003, Y 14,528983 |
| Area estimated                                       | 197,260 km <sup>2</sup>   |
| Predominant ECRM occurrences (prospecting – deposit) | Phosphates                |
| Country coverage                                     | Senegal, The Gambia       |

### 7.2.1 Location

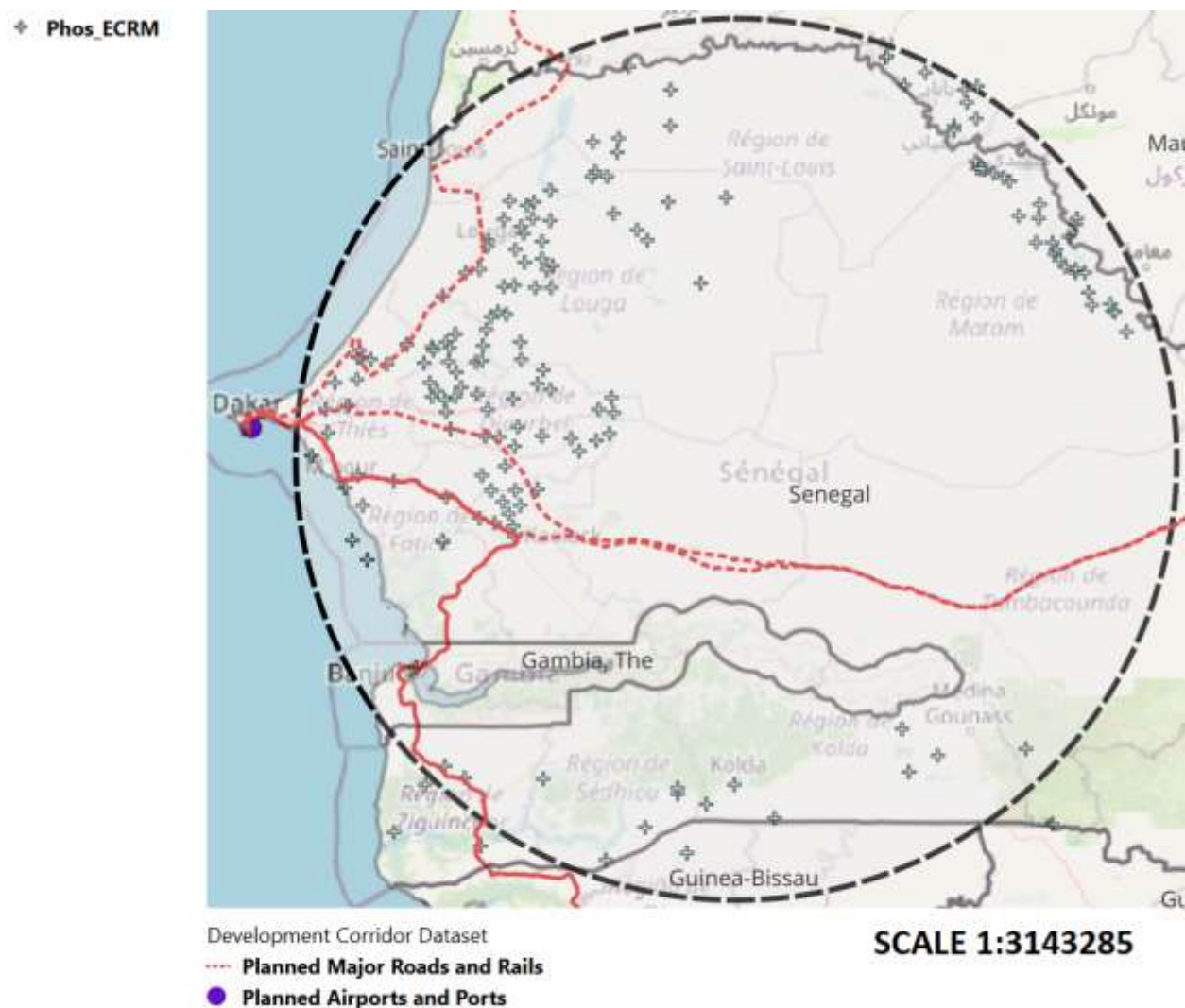


Figure 62 Location of Cluster 2: Senegal

### 7.2.2 Summary

Cluster 2 is especially rich in phosphate occurrences. Both Senegal and The Gambia are identified as politically stable countries. Given the regions abundant ECRM resources, numerous exploration, mining, and processing operations currently exist. There is, however, great potential to further develop the region to capitalise on the vast phosphate occurrences so far identified.

Take-off investments can especially be made in exploration projects to help them reach production, as well as to strategically develop processing facilities to exploit phosphate occurrences with similar mineral structures. This process is not straightforward, though, since sulfuric acid is required in the processing of phosphate rock while phosphoric acid is one of the products. Transporting these acids is difficult and production plants are therefore ideally to be located close to a port.

Road infrastructure is adequately developed, of which several major roadways stemming from Dakar have been highlighted as development corridors and have since received funding for their rehabilitation and modernisation. The Port of Dakar is well-established and plays a vital role in Senegal’s trade industry. Current infrastructure developments in the Port of Ndayane and the Banjul-Barra Bridge will guarantee large increases in trade volume in the region. The Dakar to Bamako Railway is the regions’ only rail infrastructure and links the capitals of Senegal and Mali. Lucrative business opportunities exist in extending rail infrastructure into ECRM rich areas to increase logistical efficiency and relieve the already stressed road network. Investments in energy generation and distribution may be necessary to provide stable power to ECRM rich zones. Senegal is a country with abundant renewable energy resources, notably solar and wind, which related infrastructure developments should exploit. Adequate communication is provided by the Main One, Atlantis-2, SAT-3/WASC, and the Africa Coast to Europe (ACE) submarine fibre-optic networks. Synergies are identified with the ongoing works of the Economic Community of West African States (ECOWAS) and the New Partnership for Africa’s Development (NEPAD) of the African Union. Completed and ongoing development corridor projects have been strongly backed by the African Development Bank, the World Bank, the EU, and numerous other public and private institutions. Cross-border development projects could interact with projects in cluster 1.

7.2.3 Assessment

**Main investment needs:** mining, processing, road, rail, energy, communications.

|                              |                                                                                                                                                                                                                                                                                                                                       |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in The Gambia and Senegal. With respect to the African continent, The Gambia is ranked 9 <sup>th</sup> and Senegal 17 <sup>th</sup> of the 53-country dataset as of 2022. |
| Artisanal Small-Scale Mining | Senegal and The Gambia are no relevant ASM producer countries for ECRM in Africa; according to the ASM Inventory (2023), ASM activities exist for gold but not for ECRMs.                                                                                                                                                             |

|                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Mining</b>                         | The main mining products of Senegal include gold, clays and attapulgitite, iron ore, mineral sands, and phosphates. Investments can be made to support phosphate exploration projects turning operational.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Processing facilities</b>          | Available data indicates that there are currently five phosphate processing facilities in operation near the capital of Dakar. Investments can be made in processing facilities to exploit locations with high densities of phosphate occurrences, with strategic locations near planned or active development corridors. Larger capacity facilities should be considered that handle throughput from multiple operations to minimise CAPEX while simultaneously meeting production requirements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Road / shipping infrastructure</b> | <p>Road infrastructure sufficiently covers the region and reaches most of the identified phosphate deposits. Primary roads (highways and trunk roads) are scarce yet funnel efficiently towards the capital city of Dakar and provide access to neighbouring countries and respective ports. Development corridors exclusively focus on the rehabilitation and modernisation of existing primary roadways, including the construction of the Banjul-Barra Bridge as part of the Dakar-Lagos highway reconstruction project.</p> <p>Established mining operations and mineral processing facilities are located proximal to primary roadways. The vast mapped phosphate deposits are accessible via primary (national) or secondary (regional) roads. Nevertheless, numerous deposits in the northwest are currently not accessible by road. Investments can be made to improve the quality of existing secondary roads to ensure effective transport of high payload vehicles in all weather conditions, as well as to provide access to economically important areas.</p> <p>The Senegal River could be used for inland shipping of equipment/personnel or to transport material to the coast. This, however, would require extensive works and an estimated investment of US\$ 500m to make the river navigable.</p> |
| <b>Rail infrastructure</b>            | <p>Rail infrastructure in Senegal is limited. The Dakar to Bamako Railway is the regions' only rail infrastructure and links the capitals of Senegal and Mali. The railway stopped operating in 2010 after falling into disrepair and has since been identified as a development corridor with dire investment needs. Accordingly, Chinese rail companies have won contracts worth US\$ 1.2bn and US\$ 2bn in Senegal and Mali, respectively, to rehabilitate and modernise the line. Geopolitical unsettlements have nevertheless stalled the project.</p> <p>The high density of phosphate occurrences in Senegal's northwest region, together with the lack of primary (sealed) road infrastructure, makes for a lucrative investment opportunity. Connecting this rich region by rail to the capital and port of Dakar would benefit the feasibility of many projects, ensure reliable logistics, and relieve the already over-stressed road network.</p>                                                                                                                                                                                                                                                                                                                                                          |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Airports | <p>Senegal has 20 airports of which nine have paved runways and eleven unpaved runways. Léopold Sédar Senghor International Airport and Blaise Diagne International Airport are the country's two major airports, primarily serving Dakar. Smaller regional airports may be useful for transport of personnel and goods to some of the region's phosphate occurrences. Since Senegal's major port is also located in Dakar, material can be transported to the city for export by either ship or plane. Imported materials can be locally re-directed by rail or road infrastructure.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Ports    | <p>The Port of Dakar is the main port of the Senegal and accounts for more than 90 % of Senegalese foreign trade. Dakar has one of the largest deep-water seaports along the West African coast. The Senegalese government has established an independent entity to manage the port, namely the Société Nationale du Port Autonome de Dakar (SN-PAD) or Dakar Port Authority. The Port of Banjul in Gambia may also be utilised to manage the transport and storage of goods in the region. The Banjul seaport plays an important role in the country's economy and accounts for almost 90 % of the country's trade in terms of volume and weight and is strategically advantageous for ECRM deposits in the regions south. The construction of the Banjul-Barra Bridge as part of the Dakar-Lagos development corridor will furthermore allow access from the north of the Gambia river and may supplement and relieve the Port of Dakar. Construction of the US\$ 1.1bn Ndayane Port Project, located 80 km south of Dakar and funded by Dubai-based global port operator DP World, commenced in January 2022, and is expected to be completed in 2027. The port will contain state-of-the-art port infrastructure that will reinforce the country's position as a major trade hub and gateway in West Africa.</p> |
| Energy   | <p>Power stations with generation capacities ranging between 100-1000 MW (non-renewable) are located proximal to Dakar and are connected via high and medium voltage transmission lines. Power stations with capacities ranging between 10-100 MW are similarly located near Dakar, as well as proximal to the Cairo-Dakar and Dakar-Lagos development corridor highways. A number of these are conveniently situated to mapped ECRM occurrences, some of which harnessing renewable energy sources (solar and biomass). Smaller power stations with generation capacities &lt;10 MW are sporadically dispersed throughout the region (few renewably sourced), however the central and eastern areal is largely disconnected. Nevertheless, all mapped phosphate occurrences are within acceptable reach of established power networks. Investment in renewable energies in the highly dense phosphate zone slightly east and northeast from Dakar, as well as along the northeast border with Mauritania, could be valuable for the success of the projects. Further investments may be made in upgrading the capacities of power transmission lines to ECRM rich areas.</p>                                                                                                                                        |



|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Communication | Senegal connects to more than 40 countries through four submarine fibre optic cables: Main One, Atlantis-2, SAT-3/WASC, and the Africa Coast to Europe (ACE) cable. Of this, Senegal is experiencing increased availability of 3G/4G fibre optic services in the country, and limited 5G testing in Dakar. Orange (Sonatel) is the number one mobile service operator, followed by Free Senegal (formerly Tigo) and Espresso Senegal/Sudatel. Senegal is an expected landing stop for the planned 2Africa cable, with a design capacity of up to 180 Tbps and developed by an international consortium including Facebook, which may lead to opportunities for carrier-neutral data centres and fibre-optic cable landing centres. In addition, an extension of the EU-funded Medusa Cable Project envisages to extend the submarine cable network to West Africa, with a first landing in Dakar. |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Table 85 Infrastructure assessment of Cluster 2: Senegal

### 7.3 Cluster 3: Morocco

|                                                      |                                                      |
|------------------------------------------------------|------------------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X -6,471507, Y 31,637291                             |
| Area estimated                                       | 168,100 km <sup>2</sup>                              |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Cobalt, Manganese, Tin, Tungsten, Phosphates |
| Country coverage                                     | Morocco                                              |

#### 7.3.1 Location

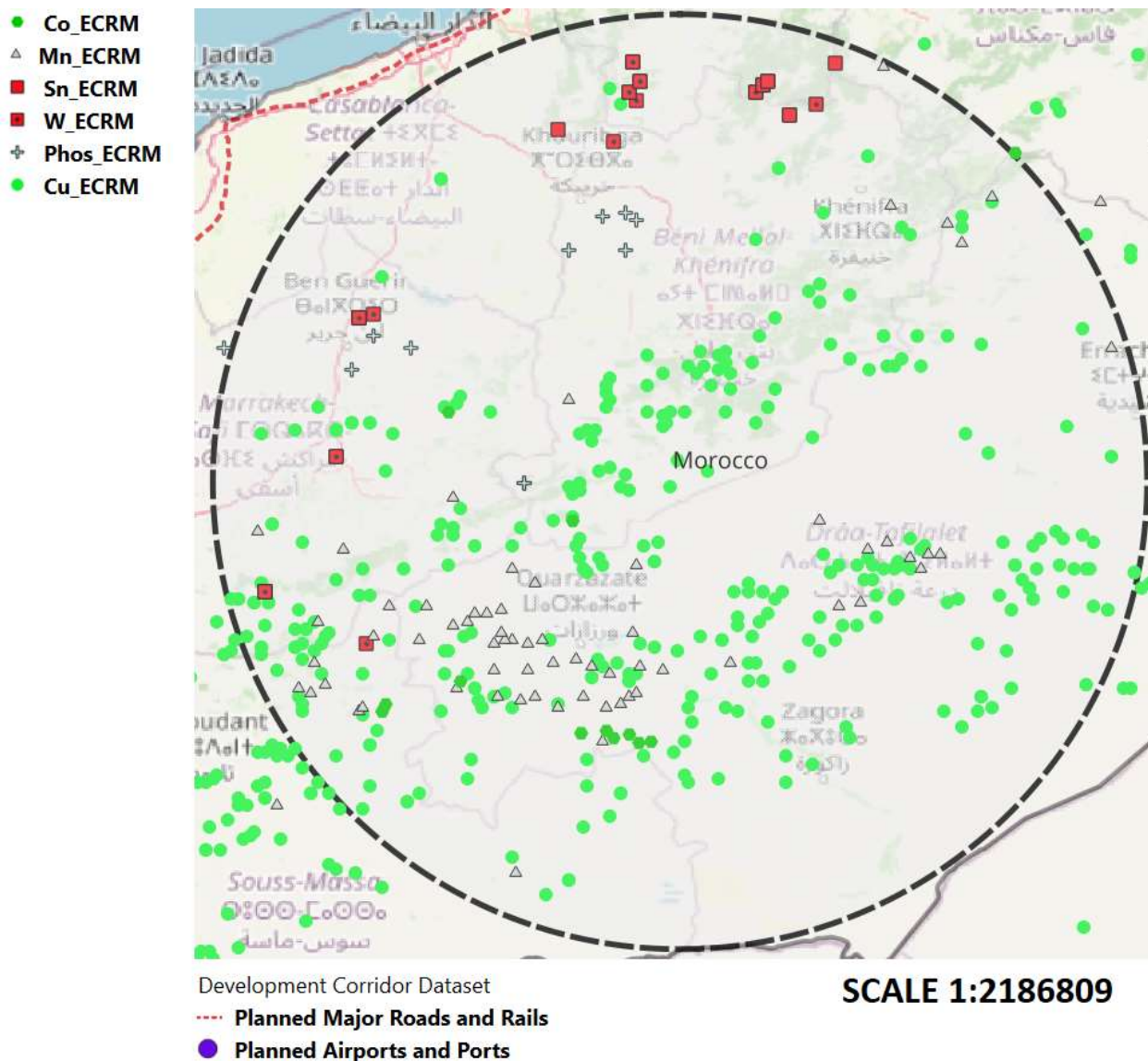


Figure 63 Location of Cluster 3: Morocco

#### 7.3.2 Summary

Cluster 3 is rich in diverse ECRM occurrences, of which copper, cobalt, manganese and phosphate are especially prominent. The cluster is fully encapsulated within Morocco, a country considered

to be moderately politically stable. Morocco is host to significant mineral resources, including the largest phosphate deposits in the world, which account for around 77 % of global reserves. Deemed Africa's most attractive investment destination in 2021 by the Fraser Institute in Canada, Morocco's ECRM mining landscape holds considerable potential. In baryte mining, production currently stems primarily from artisanal mining of barite, accounting for 90 % of the industry's output. Nevertheless, ASM remains undercapitalised and lacks efficiency with most of the extraction done at surface levels. Larger players such as the nationally owned Office Chérifien des Phosphates (OCP), are seeing large mining projects take traction. Morocco has also been a small long-time producer of cobalt. There is, however, great potential to further develop the region to capitalise on the vast ECRM occurrences so far identified. In particular, the southern region of the Atlas Mountains is largely underdeveloped in terms of established infrastructure yet hosts the majority of the mapped ECRM occurrences. Take-off investments can therefore be made in exploration projects in this region to help them reach production, as well as to strategically develop processing facilities and the associated supporting infrastructure to exploit similar ECRM occurrences. Road and rail infrastructure are adequately developed, although considerations should be made to improve/modernise roadways and/or to construct a new railway south of the Atlas Mountains. Port infrastructure is well established, of which ongoing and planned projects will see the expansion and modernisation of several ports and accordingly an increase in trading capacity. Investments in energy generation and distribution may be necessary to provide stable power to ECRM rich zones, especially south of the Atlas Mountains. Adequate telecommunication infrastructure is provided by Maroc Telecom, Orange, and Inwi. The cluster region does not intercept any current or planned development corridors, rather lies close to the Cairo-Dakar Highway Project, following the continent's northern coast from Senegal to Egypt. The strategic location of the corridor, nevertheless, presents opportunities to utilise infrastructure facilities along the northern African coast to disperse and manage trade volume. Synergies exist between ongoing state-led development port and airport projects, as well as continued developments in renewable energy initiatives.

### 7.3.3 Assessment

**Main investment needs:** mining, processing, road, rail, ports, energy.

#### Political stability

According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in Morocco. With respect to the African continent, Morocco is ranked 22<sup>nd</sup> of the 53-country dataset as of 2022.

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Artisanal Small-Scale Mining   | Morocco is a relevant ASM producer country for ECRM in Africa. ECRMs exploited via ASM practices include mainly baryte beside non-ECRMs lead, gold, and zinc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Mining                         | Morocco has mining operations in phosphates, lead, zinc, copper, gold, silver, cobalt, manganese, fluorine, fluorspar, and barite. Investments can be made to support ECRM exploration projects turning operational and to support the scaling up                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Processing facilities          | Numerous processing facilities already exist within the region. Existing infrastructure accommodates the processing of cement, lime, phosphates, talc, fluorspar, zinc, barite, cobalt, nickel, copper, arsenic, silver, gold, and manganese. Investments can be made in processing facilities to exploit similar mineral occurrences in strategic locations. Additional studies to identify the extent of the region's mineral resources and minable assets, e.g., copper occurrences, should be conducted to identify synergies between for investment purposes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Road / shipping infrastructure | Road infrastructure sufficiently covers the region and reaches most of the identified ECRM deposits. Primary roads (highways and trunk roads) are scarce, comprising of the A3 and A4 highways and short segments of trunk roads. These highways extend to the foothills of the Atlas Mountains, whereafter secondary roads (national and regional) connect the remainder of the defined region. Nevertheless, the vast ECRM occurrences are found in the Atlas Mountains or south thereof, of which road access is not always granted. Investments can be made to improve the quality of existing secondary roads to ensure the effective transport of high payload vehicles in all weather conditions, as well as to provide access to economically important areas. This is especially noteworthy south of the Atlas Mountains, where an upgrade in road infrastructure from a geographically viable location (e.g., continuation of the trunk road from Taroudant) would benefit the vast majority of ECRM deposits in the region. |
| Rail infrastructure            | Morocco's railway network includes 1,300 km of track, with 120 stations serving passengers, and 15 serving freight. Of this, only a short portion serves the cluster area, linking the townships of Marrakesh and Oued Zem to the coastal cities of Casablanca and Safi. The extent of the rail network is largely limited by the geographical limitations of the Atlas Mountains. Nevertheless, rail infrastructure currently serves large ongoing ECRM projects in the region. Investment in new rail line south of the Atlas Mountains and serving the Agadir Port may be prosperous for the region. This could provide a streamlined logistical solution to service the numerous ECRM occurrences in the region, whilst furthermore linking an additional port to the nation's rail network.                                                                                                                                                                                                                                       |

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Airports      | Morocco has 26 airports, all operated by the National Airports Office (ONDA). Morocco's National Airports Office intends to invest US\$ 200m in the development and enhancement of the airports, specifically the freight zones of the Casablanca and Tangier airports. The Casablanca airport recently expanded and modernised its Terminal One at a cost of US\$ 160m. Morocco's two largest airports, namely Casablanca Mohammed V International Airport and Marrakesh Menara International Airport, are found within the cluster and can adequately serve the ECRM rich region. Morocco's National Airports Office committed US\$ 464.3m in 2023 to support the growth of airports in Casablanca, Marrakech, Agadir, and Tangier. Smaller regional airports may be useful for transport of personnel and goods to some of the region's ECRM occurrences. Major airports within or nearby the cluster are well connected with existing road, rail, and port infrastructure.          |
| Ports         | Morocco has 27 commercial ports that handled 192.1 million t of merchandise traffic in 2021. Morocco's 2030 port strategy calls for nearly US\$ 7.5bn to upgrade and expand the 27 ports along the country's Atlantic and Mediterranean coasts, building expansions and upgrades. As part of the 2030 National Port Strategy, Morocco's National Ports Authority (ANP) will invest nearly US\$ 600m between 2018-2023. The investment is dedicated primarily to large-scale infrastructure projects aimed at keeping up with changes in maritime transport and trade outside of Morocco.                                                                                                                                                                                                                                                                                                                                                                                                |
| Energy        | Power stations with generation capacities exceeding 1000 MW lie northwest outside of the cluster region, however, serve the defined region north of the Atlas Mountains via extra high voltage power lines. To support this, numerous 100-1000 MW and 10-100 MW renewable power stations (hydro, solar, and wind) are situated within the cluster. These serve both the northern and southern regions of the dividing Atlas Mountains. Nevertheless, power transmission lines are more prominent in the cluster's northern region. This infrastructure serves multiple ECRM projects and lies proximal to numerous mapped occurrences. The vast ECRM occurrences in the southwestern and southern regions of the cluster, however, do not have adequate access to power (stations nor transmission lines). Investment in additional renewable energies and a thorough extension of the power transmission network may be lucrative to exploit the rich southern regions of the cluster. |
| Communication | Morocco's mobile market is one of the more mature in the region, with a penetration rate of 137.5 %. The three mobile network operators – Maroc Telecom, Orange, and Inwi – offer fixed-line and fixed-wireless services. They have developed mobile data services based on the extensive reach of LTE infrastructure. All three telecom operators have successfully completed their pilot tests for 5G and stand ready to deploy their own 5G networks in Morocco. Morocco is furthermore one of multiple northern African countries included in the EU-funded Medusa Project – a project aimed at interconnecting southern European countries with northern African countries. The project will lay 8,670 km of submarine fibre optic cable with 24 fibre pairs, each with a speed of 20 Tbps.                                                                                                                                                                                        |

Table 86 Infrastructure assessment of Cluster 3: Morocco



## 7.4 Cluster 4: Northern and Western Africa (Inland)

|                                                      |                                             |
|------------------------------------------------------|---------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 5,615766, Y 20,464693                     |
| Area estimated                                       | 1,513,700 km <sup>2</sup>                   |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Fluorite, Phosphates, Tin, Tungsten |
| Country coverage                                     | Algeria, Mali, Niger                        |

### 7.4.1 Location

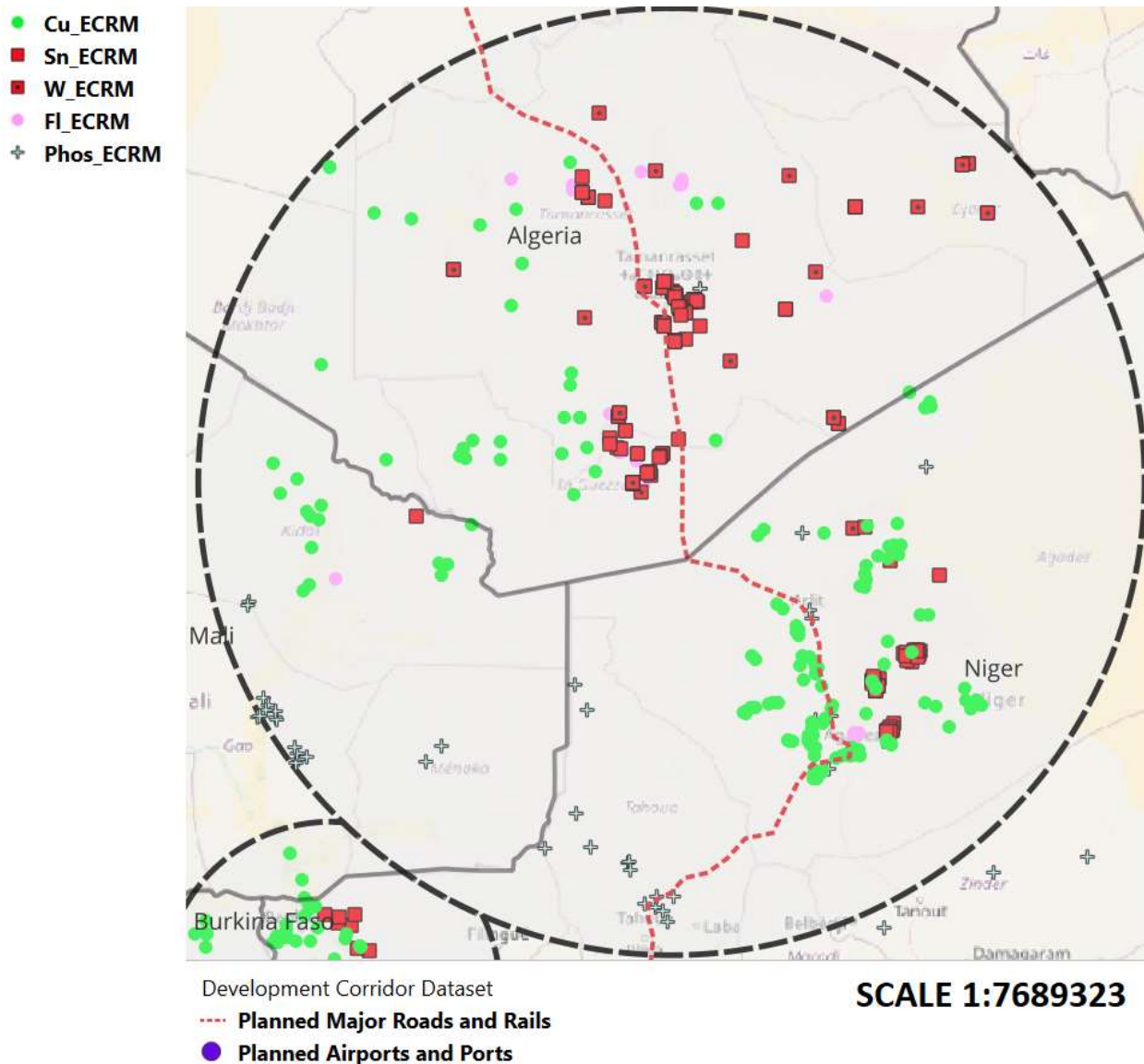


Figure 64 Location of Cluster 4: Northern and Western Africa (Inland)



### 7.4.2 Summary

Cluster 4 is rich in copper, phosphate, tin, and tungsten occurrences. The region, however, faces many challenges associated with political instability. The regions inland isolation poses further challenges to accessibility and trade, requiring large-scale development projects. Nevertheless, the Trans-African-Highway network has seen the rehabilitation and construction of the Trans-Sahara Highway, connecting the region to the northern and southern coastlines in Algeria and Nigeria, respectively, and is reported to be 97 % complete. There are only few established mining projects and processing facilities documented in the cluster area. There is, however, great potential to further develop the region to take advantage of the vast ECRM occurrences so far identified. Take-off investments can especially be made in exploration projects to help them reach production, as well as to strategically develop processing facilities to exploit ECRM occurrences with similar mineral structures. Due to the large haulage distances from project to port, processing in the region will largely reduce transport costs. Road infrastructure is scarce and heavily dependent on the Trans-Saharan development corridor. The highway is the regions lifeline, connecting it to ports in the northern and southern coasts, and might be used for transporting high-value commodities. Investments in the maintenance and management of the highway may therefore be crucial for the region's success. Investments in energy generation and distribution will be necessary to support the take-off of ECRM projects. The region's abundant solar potential makes it a stand-out candidate to support off-grid power supply and to potentially establish a small-scale regional network. Investment is needed to improve mobile network coverage in remote areas not connected to major roads or cities in the cluster's respective countries. Synergies are identified with the ongoing works of the United Nations Economic Commission for Africa (UNECA), the African Development Bank (AfDB), and the African Union. Cross-border development projects could interact with projects in cluster 1 and 5.

### 7.4.3 Assessment

**Main investment needs:** mining, processing, road, energy, communications.

|                              |                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in Algeria, moderate in Niger, and high in Mali. With respect to the African continent, Algeria is ranked 33 <sup>rd</sup> , Niger 43 <sup>rd</sup> , and Mali 52 <sup>nd</sup> of the 53-country dataset as of 2022. |
| Artisanal Small-Scale Mining | Niger is a minor ASM producer country for ECRM in Africa. ECRMs exploited via ASM practices include mainly tin beside non-ECRMs gold and salt.                                                                                                                                                                                                                                    |

|                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Mining</b>                         | The main mining products in the cluster region include iron ore, gold, zinc, lead, mercury, phosphates, kaolin, uranium, coal, and cement. Investments can be made to support ECRM exploration projects turning operational, as well as potentially turning ASM sites industrial.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Processing facilities</b>          | Mineral processing infrastructure is limited within the cluster, with only a single coal processing plant found in Niger. Two additional facilities for processing phosphate and cement are mapped slightly outside of the defined region in Mali and Niger, respectively. Investments can be made in processing facilities to exploit similar mineral occurrences in strategic locations. The existence of notable copper, tin, fluorite, and phosphate bundles found proximal to the Algiers-Lagos development highway may present lucrative business opportunities to support the take-off of multiple ECRM projects.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Road / shipping infrastructure</b> | Primary road infrastructure (asphalt roads) in the cluster region consists solely of the Trans-Sahara Highway (Algiers-Lagos development highway). The highway passes through Algeria and Niger in its north-south lying orientation. On the 13.02.23 the African Development Bank (AfDB) reported the project to be at 97 % completion, with only 60 km of construction work remaining in Niger. The remaining unpaved portion of the development corridor, however, lies (partially) in the cluster. According to the AfDB report, the project was expected to be finished within 12 months of publishing (February 2024). This corridor plays a crucial role in supporting the regions ECRM potential. Secondary roads scarcely branch off the Trans-Sahara Highway, providing non-sealed road access to few additional locations. Investments in the maintenance of the Trans-Sahara Highway could be vital in ensuring reliable supply chains. Additional investments in access roads from the Trans-Sahara Highway to ECRM-rich zones will be necessary to help bring projects into operation. |
| <b>Rail infrastructure</b>            | There is neither existing nor planned railway infrastructure in the cluster region. Due to the cluster's inland isolation, investments in rail infrastructure projects may not be financially feasible.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Airports</b>                       | The cluster contains few international and numerous regional airports dispersed throughout the respective countries. International airports of Aguenar and Mano Dayak in Algeria and Niger, respectively, serve the cluster with larger passenger and cargo capacities. From here, personnel and goods may be transported to smaller regional airports for distribution to the regions ECRM occurrences.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Ports</b>                          | No port facilities are contained within the cluster. Ports accessible to the cluster include the Port of Apapa (Nigeria) and Port Autonome de Cotonou Pac (Benin) south of the cluster, and the ports of Bethioua and Skikda (Algeria) to the north. Access to these ports is primarily granted by the Trans-Saharan Highway, and thereafter supported by the Abidjan-Lagos Road, and the Cairo-Dakar Highway (Trans-Maghreb Motorway).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Energy        | <p>Power infrastructure in the large cluster area is extremely limited. A total of 8 power plants with maximum generation capacities of 10-100 MW are found in the defined area, of which the majority (6) are situated proximal to the Trans-Sahara highway. The scarce power stations, however, are mostly strategically located with respect to the mapped ECRM occurrences. Smaller power stations with generation capacities &lt;10 MW support this infrastructure and extend to further reaches of the region. Nevertheless, power transmission lines are almost non-existent, limiting the power stations to individual projects/areas. Most stations generate power with non-renewable sources (primarily diesel); however, some solar plants exist. Investment in power generation and transmission infrastructure will be necessary to assist the ECRM projects in becoming operational.</p>                                                                                                                                                                                                                                                                                                                             |
| Communication | <p>Significant mobile network providers in the cluster are Ikatel, Malitel, Orange Mali, Mobilis, Optimum Telecom Algerie, Wataniya Telecom Algerie, Niger Telecom, Zamani Telecom, and Moov Africa, delivering up to 4G LTE connectivity. Development is needed to improve mobile network coverage in remote areas not connected to major roads or cities in the cluster's respective countries. Algeria connects to Europe via four fibre-optic submarine cables. Since 2016, Algeria has deployed more than 120,000 km of optical fibre throughout the country to help close the gap in broadband adoption rates. Recent international investment to complete the Trans-Saharan Dorsal optical fibre (SDR) network has furthermore extended the reach of fibre infrastructure in Niger. Leading satellite and terrestrial network provider, Intelsat, has two satellite earth stations in Mali. Nevertheless, Mali is largely dependent on neighbouring countries via fibre-optic links for international bandwidth and access to submarine cables. Investments can be made in telecommunications equipment (hardware and software) and cables (fibre optic and marine), especially along the Trans-Sahara Highway project.</p> |

**Table 87 Infrastructure assessment of Cluster 4: Northern and Western Africa (Inland)**

## 7.5 Cluster 5: Western Africa (Inland)

|                                                      |                                              |
|------------------------------------------------------|----------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 1,133651, Y 13,762124                      |
| Area estimated                                       | 192,600 km <sup>2</sup>                      |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Graphite, Manganese, Tin, Phosphates |
| Country coverage                                     | Mali, Niger, Burkina Faso                    |

### 7.5.1 Location

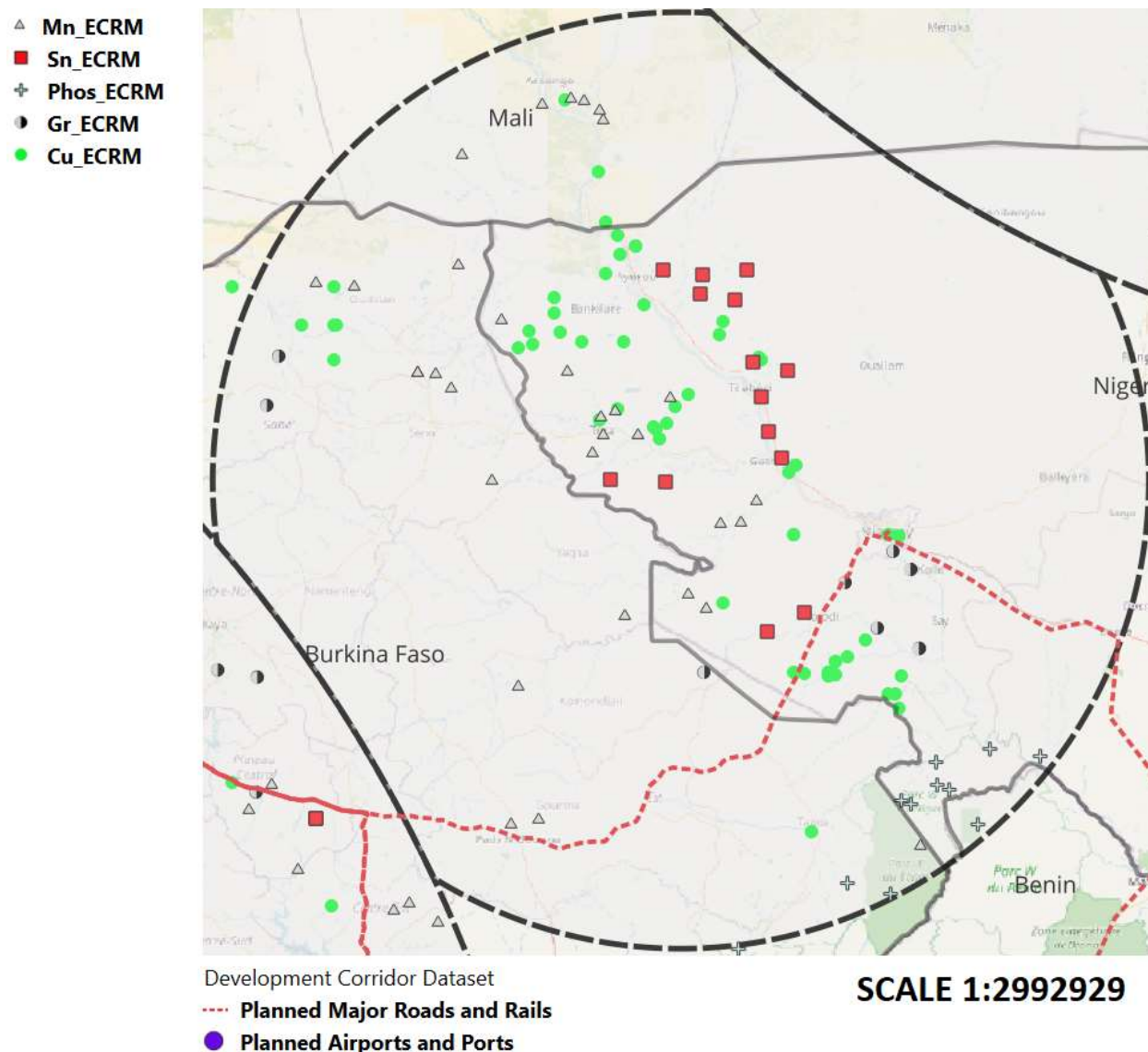


Figure 65 Location of Cluster 5: Western Africa (Inland)

### 7.5.2 Summary

Cluster 5 is rich in copper, manganese, tin, and phosphate occurrences. The region, however, faces many challenges associated with political instability. The regions inland isolation poses

further challenges to accessibility and trade. Nevertheless, the Trans-African-Highway network has seen the rehabilitation and construction of the Trans-Sahelian Highway, connecting the region to other nearby development corridors, railways, and ports. There are only few established mining projects documented in the cluster area, whilst no processing facilities currently exist. There is, however, great potential to further develop the region to take advantage of the vast ECRM occurrences so far identified. Take-off investments can especially be made in exploration projects to help them reach production. Due to the large haulage distances from project to port, mineral processing in the region will largely reduce transportation costs. As such, strategic zones should be sought out to build processing facilities capable of managing feeds from several operations with similar mineral properties. Road infrastructure is moderate, however heavily dependent on the Trans-Sahelian development corridor. Investments in the maintenance and management of the highway will be crucial to ensure the transport corridor’s success. Funding of the Niamey-Cotonou Highway has been suspended due to political dismay; however, the highway could be vital to the region’s prosperity. The Niamey-Cotonou Railway is grossly incomplete, of which the installed infrastructure is now rendered unusable. Rehabilitating and completing the estimated US\$ 4bn (2018) railway project could largely reduce transport times and costs. Investments in energy generation and distribution will be necessary to support the take-off of ECRM projects. The region’s proximity to the Niger River makes hydro energy an obvious candidate to sustainably energise the region. The cluster’s solar abundance offers an additional power generation alternative more suitable for isolated projects further away from the Niger. Investment is needed to improve mobile network coverage in remote areas not connected to major roads or cities in the cluster’s respective countries. Synergies are identified with the ongoing works of the African Development Bank (AfBD) and the OPEC Fund for International Development. Cross-border development projects could interact with projects in cluster 1, 2 and 4.

7.5.3 Assessment

**Main investment needs:** mining, processing, road, rail, energy, communications.

|                              |                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as moderate in Niger and Burkina Faso, and high in Mali. With respect to the African continent, Niger is ranked 43 <sup>rd</sup> , Burkina Faso 45 <sup>th</sup> , and Mali 52 <sup>nd</sup> of the 53-country dataset as of 2022. |
| Artisanal Small-Scale Mining | Niger is a minor ASM producer country for ECRM in Africa. ECRMs exploited via ASM practices include mainly tin beside non-ECRMs gold and salt.                                                                                                                                                                                                                                          |

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mining                         | The main mining products in the cluster region include gold, uranium, coal, zinc, and manganese. Investments can be made to support ECRM exploration projects turning operational, as well as potentially turning ASM sites industrial.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Processing facilities          | Based on available data, there are no mapped mineral processing facilities within the cluster's defined boundary. Investments can be made in processing facilities to exploit similar mineral occurrences in strategic locations. The existence of notable copper, tin, and phosphate bundles in Niger presents lucrative business opportunities to support the take-off of multiple ECRM projects.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Road / shipping infrastructure | <p>Road infrastructure is moderately dispersed throughout the landlocked cluster. Nevertheless, the development corridor projects of the Trans-Sahelian Highway (Trans African Highway 5) and the Niamey-Cotonou Highway will largely serve the southern portion of the cluster. The cluster's more prominent Trans-Sahelian project is complete, however, a lack of maintenance poses a threat to its functionality. Political instability in Niger saw funding of the US\$ 504m Niamey-Cotonou rehabilitation project from the American agency Millennium Challenge Corporation (MCC) suspended. Secondary roads (national and regional) supplement these major thoroughfares and provide nearby access to the majority of the mapped ECRM occurrences. Investments can be made to improve the quality of existing secondary roads leading towards the development corridor highways to ensure the effective transport of high payload vehicles in all weather conditions, as well as to provide access to economically important areas.</p> <p>The Niger River bisects the cluster and is claimed to be navigable to small vessels from the Malian border town of Labbezanga to the Atlantic coast. Navigation, however, is seasonally dependent due to the fluctuations in water level in the rainy and dry seasons. The proximity of the Niger River to many of the cluster's central and northern ECRM occurrences may prove beneficial for the transportation of goods. Investments in upgrading and managing the navigable waterway to the intersection with the development corridor highways in Niamey could therefore be important for the otherwise isolated copper, tin, and manganese occurrences found in the north.</p> |
| Rail infrastructure            | Rail infrastructure is extremely limited in the cluster. There is currently one railway in Niger between Niamey and Dosso, which lies in the cluster region. The railway was built with the goal of connecting Niamey to the rail network in Benin, however construction ceased prior to reaching Dosso due to litigation battles between competing private entities. The tracks now lie dormant and unused, of which weathering effects have caused extreme damage and deformation. Investments in the historical railway project to connect Niamey with the port of Cotonou in Benin would be very beneficial to the cluster. The 740 km railway project was estimated to cost US\$ 4bn in 2018.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |



|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Airports      | Diori Hamani International Airport in Niamey (Niger) is the sole international airport serving the cluster. Smaller, regional airports are dispersed throughout all encapsulated countries and can be used to transport material or persons. The Trans-Sahelian Highway furthermore links the outer-lying Thomas Sankara International Airport in Ouagadougou (Burkina Faso) to the cluster, providing access to the Abidjan-Ouagadougou railway. Ouagadougou will thus likely play an important role in the cluster's trade networks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Ports         | No port facilities are contained within the cluster. Ports accessible to the cluster include the Port of Abidjan (Côte d'Ivoire), the Port of Tema (Ghana), the Port of Lomé (Togo), the Port of Kpeme (Togo), and the Port of Cotonou (Benin). Access to these ports is granted by the Cotonou-Niamey Road, the Trans-Sahelian Highway in combination with either the Abidjan-Ouagadougou Road or the Abidjan-Ouagadougou railway, as well as the Abidjan-Lagos Road.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Energy        | Power infrastructure in the cluster is quite dispersed and largely off-grid. Of the five larger 10-100 MW (non-renewable) power stations, three are connected to a grid network, whilst the other two are stand-alone installations. The smaller (<10 MW) power stations are exclusively off-grid and primarily sourced by diesel generators, with few thermal and hybrid (diesel-biomass) installations. The three on-grid power stations connect to the cluster's only power transmission cables leading towards Sokoto in Nigeria. These stations are connected via high voltage power lines. The limited power infrastructure mildly serves the ECRM occurrences, with most projects currently having no access to power. Expanding the on-grid network from Niamey northwest along the Niger River towards the two larger stand-alone power stations would be beneficial for the region. Investments in large on-grid renewable power stations (hydro or solar) and battery storage facilities should furthermore be considered to ensure power demand can be met whilst guaranteeing power security. |
| Communication | Mobile network providers in the cluster are Airtel Niger, Zamani Telecom, MOOV Africa Niger, and Niger Telecom in Niger; TELMOB, Orange Burkina Faso SA, and TELECEL FASO SA in Burkina Faso; and Orange Mali, Sotelma, Alpha Telecom, and Mobilis in Mali. The land-locked countries are underdeveloped in telecommunications infrastructure with respect to other West-African nations. National fibre backbone projects are in progress with the aim of connecting more municipalities with larger cities, as well as to provide additional connectivity via terrestrial cables in neighbouring countries. Business opportunities exist to support the build-out and expansion of the telecommunications sector across all three countries, especially in the bordering region that characterises the cluster.                                                                                                                                                                                                                                                                                          |

**Table 88 Infrastructure assessment of Cluster 5: Western Africa (Inland)**

## 7.6 Cluster 6: Nigeria

|                                                      |                        |
|------------------------------------------------------|------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 8,710668, Y 9,954540 |
| Area estimated                                       | 93,500 km <sup>2</sup> |
| Predominant ECRM occurrences (prospecting – deposit) | Tin, Niobium-Tantalum  |
| Country coverage                                     | Nigeria                |

### 7.6.1 Location

- Sn\_ECRM
- Nb\_ECRM

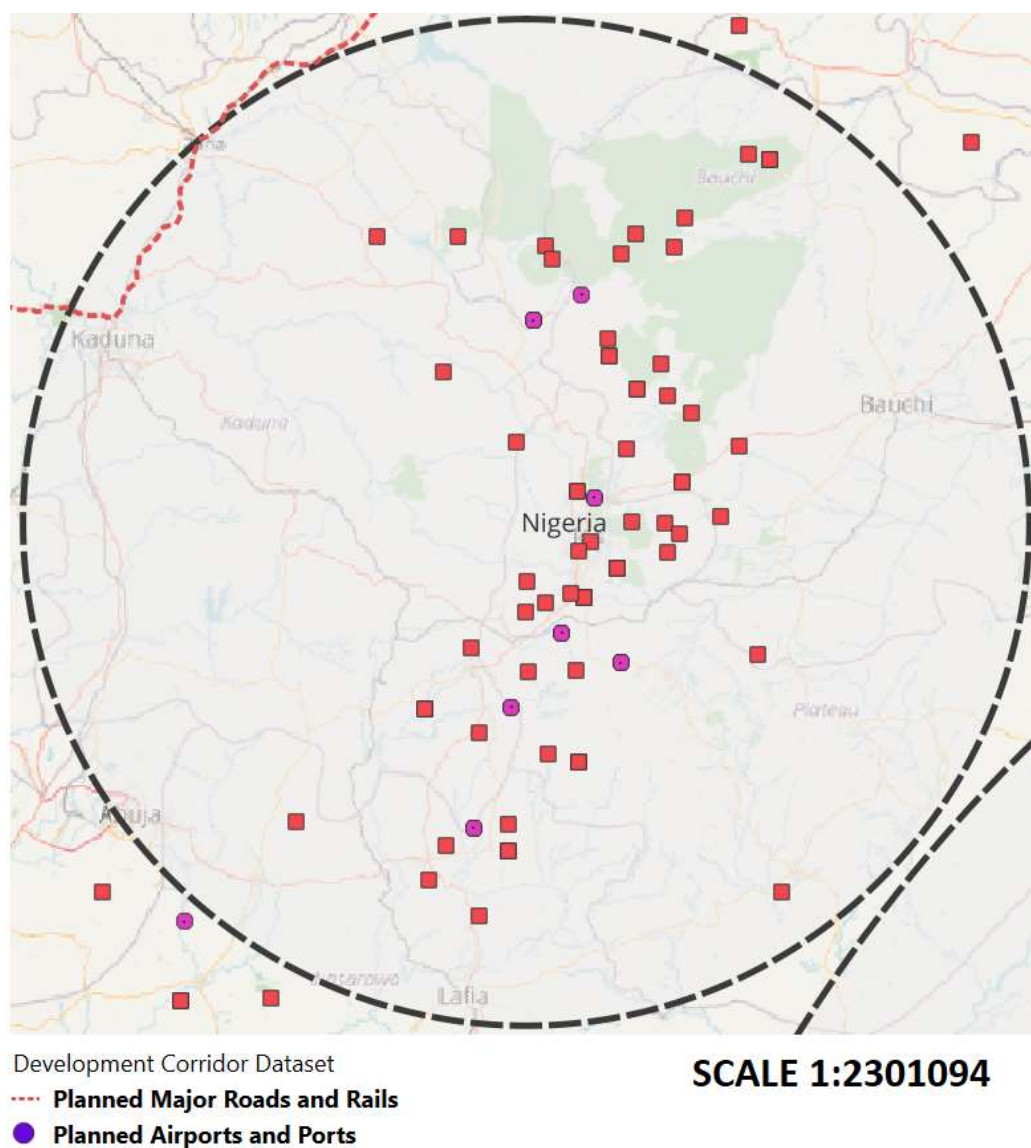


Figure 66 Location of Cluster 6: Nigeria

### 7.6.2 Summary

Cluster 6 is rich in tin and niobium-tantalum occurrences and is solely located in Nigeria. The region, however, faces many challenges associated with political instability. The region is

adequately developed with respect to road, rail, airport, and power infrastructure. The Lagos-Kano-Jibiya Road is the only development corridor project within the cluster's boundaries, providing access to the Port of Apapa (Lagos). There are several established mining projects in the cluster, as well as one sulphur processing plant. New policies require raw products to be processed domestically, of which the homogenous mineralisation zone and the existing surrounding infrastructure make for a lucrative investment opportunity. Take-off investments can be made in exploration projects to help them reach production, as well as to strategically develop processing facilities to exploit ECRM occurrences with similar mineral structures. The vast road and rail network in the region provides access to multiple ports and development corridors. Investments in the maintenance and management of major thoroughfares and the regions rail infrastructure may be crucial for the region's success. Investments may be required in power generation and/or distribution projects to support the take-off of ECRM projects. Nigeria's abundant hydro and solar potential make them stand-out candidates to support off-grid power supply and to potentially establish a small-scale regional network. An investment of approximately US\$ 2bn is required to install the remaining terrestrial fibre optic backbone. Synergies are identified with the ongoing works of the Nigerian Ports Authority and the Government of Nigeria. Cross-border development projects could interact with projects in cluster 7.

### 7.6.3 Assessment

**Main investment needs:** mining, processing, road, energy, communications.

|                              |                                                                                                                                                                                                                                                                                              |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as moderate in Nigeria. With respect to the African continent, Nigeria is ranked 46 <sup>th</sup> of the 53-country dataset as of 2022. |
| Artisanal Small-Scale Mining | Nigeria is a major ASM producer country for ECRM in Africa. ECRMs exploited via ASM practices include mainly tin and coltan, beside several other ECRMs and non-ECRMs.                                                                                                                       |
| Mining                       | The main mining products in Nigeria include gold, lead, zinc, tin, coal, bitumen, iron ore, limestone, and barite. Investments can be made to support ECRM exploration projects turning operational, as well as potentially turning ASM sites industrial.                                    |

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Processing facilities          | From the data available, merely a single processing facility (sulphur from oil refining?) exists within the cluster region. Recent developments by Nigerian policy makers requires mining companies to present business plans for so-called “value addition” in a bid to process raw products domestically. As such, investments in processing facilities will be important for creating efficient supply chains in the region. The existence of notable tin and niobium-tantalum occurrences presents lucrative opportunities to support the take-off of multiple ECRM projects.                                                                                                                                                                                                                                                                                                                                                           |
| Road / shipping infrastructure | Road infrastructure in the cluster is adequately developed, reaching most areas of the region. Accordingly, the vast tin and niobium-tantalum occurrences are accessible by road. However, national parks in the north limit infrastructure development, making mapped occurrences in these areas difficult to access. Primary roads (trunk roads) are well represented in the cluster and largely trace the ECRM occurrences found outside of the national parks. Secondary roads (national and regional) sufficiently support the highways in connecting the regional area. The cluster contains a small portion of the Lagos-Kano-Jibiya Road in the northwest – a development project aimed at improving logistical efficiency in the Lagos-Kano-Jibiya corridor. Investments to manage and maintain existing roadways, as well as to develop roadways to currently inaccessible ECRM occurrences, may present lucrative opportunities. |
| Rail infrastructure            | Rail infrastructure is very well developed in the considerably small cluster. Current infrastructure is centred around the township of Kafanchan, with respective railways branching northwest, east to northeast, and south thereof. To the south, the railway links the region with the port of Harcourt. In the cluster’s northwest, rail infrastructure is diverted in Kaduna, providing access to the capital of Abuja, as well as to the port of Lagos. Ongoing railway projects aim to link the port of Warri with both Abuja and the Lagos Kaduna development corridor. Upon completion, rail infrastructure will link the region with three separate ports, enabling a high degree of versatility in rail logistics.                                                                                                                                                                                                               |
| Airports                       | The cluster is host to numerous airports of varying scale and capacity. Sir Abubakar Tafawa Balewa International Airport in Bauchi and Nnamdi Azikiwe International Airport in Abuja service the cluster’s international market from the southwest and northeast, respectively. The smaller regional Yakubu Gowon Airport in Jos and Kaduna Airport in Kaduna service the central and northwest regions of the cluster, respectively. All airports in the cluster are conveniently located proximal to existing rail and road infrastructure and can be used as a dispatch point to distribute both exported and imported materials accordingly.                                                                                                                                                                                                                                                                                            |

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ports         | No port facilities are contained within the cluster. Ports accessible to the cluster include the Port of Apapa (Nigeria), the Port of Cotonou (Benin), the Port of Lomé (Togo), and Port Harcourt (Nigeria). Access to these ports is granted by the Lagos-Kano railway, the Port Harcourt-Maiduguri railway, the Lagos-Kano-Jibiya Road, as well as the Abidjan-Lagos Road. The Port of Cotonou is undergoing a major US\$ 680m upgrade and expansion, aiming to renovate and replace obsolete infrastructure and double the facility's handling capacity to 23 million t by 2038. Similarly, the Nigerian Ports Authority announced in late 2023 that it will invest US\$ 1.1bn in its national port rehabilitation plan (including the Port of Apapa). The numerous ports and their respective connectivity should well serve the cluster.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Energy        | Power generation infrastructure is very limited in the cluster area. Power plants within the cluster have a maximum generation capacity of <10 MW and are scarcely distributed. Within the cluster, power is sourced by a diesel, hydro, and solar. Power transmission lines are much more prominent, however, with extra high voltage power being transmitted from larger stations south and southwest of the cluster. Within the cluster, high voltage cables branch off the extra high voltage network to feed local municipalities. The established power network covers many of the mapped ECRM projects, with only minor adjustments being required to power the regions numerous tin and niobium-tantalum projects. Nevertheless, occurrences in the cluster's north have much less access to power. The occurrences in question are, however, mostly situated within or nearby the Lame Burra Game Reserve, where environmental considerations must be taken. To support the ECRM projects in the region, investments can be made to supplement the cluster's limited power generation capacity. Nigeria's vast renewable energy potential makes investments in renewable energies such as hydro and solar power very attractive. Power infrastructure for occurrences in the north is heavily dependent on project feasibility (protected land permits). |
| Communication | Nigeria is regarded as Africa's largest ICT market with about 82 % of the continent's telecoms subscribers and 29 % of internet usage. Significant mobile network providers in the cluster are Airtel, Globacom, MTN, and 9Mobile, delivering up to 5G connectivity. Five submarine fibre optic cables connect to multiple landing stations on the Nigerian coast: South Atlantic 3/West Africa Submarine Cable (SAT-3/WASC), MainOne, Globacom-1 (GLO-1), the West Africa Cable System (WACS), and the Africa Coast to Europe (ACE). Approximately 35,000 km of fibre optic cable have been deployed throughout the nation. In line with the Nigeria National Broadband Plan (NNBP 2020-2025), the government has announced that investments of approximately US\$ 2bn will be necessary to lay the additional 95,000 km of cable to ensure complete coverage of the country.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

Table 89 Infrastructure assessment of Cluster 6: Nigeria



## 7.7 Cluster 7: Western and Central Africa

|                                                      |                                                                           |
|------------------------------------------------------|---------------------------------------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 13,655109, Y 5,810200                                                   |
| Area estimated                                       | 914,000 km <sup>2</sup>                                                   |
| Predominant ECRM occurrences (prospecting – deposit) | Aluminium, Copper, Niobium-Tantalum, Tin, Titanium, Tungsten              |
| Country coverage                                     | Nigeria, Cameroon, Central African Republic, Republic of the Congo, Gabon |

### 7.7.1 Location

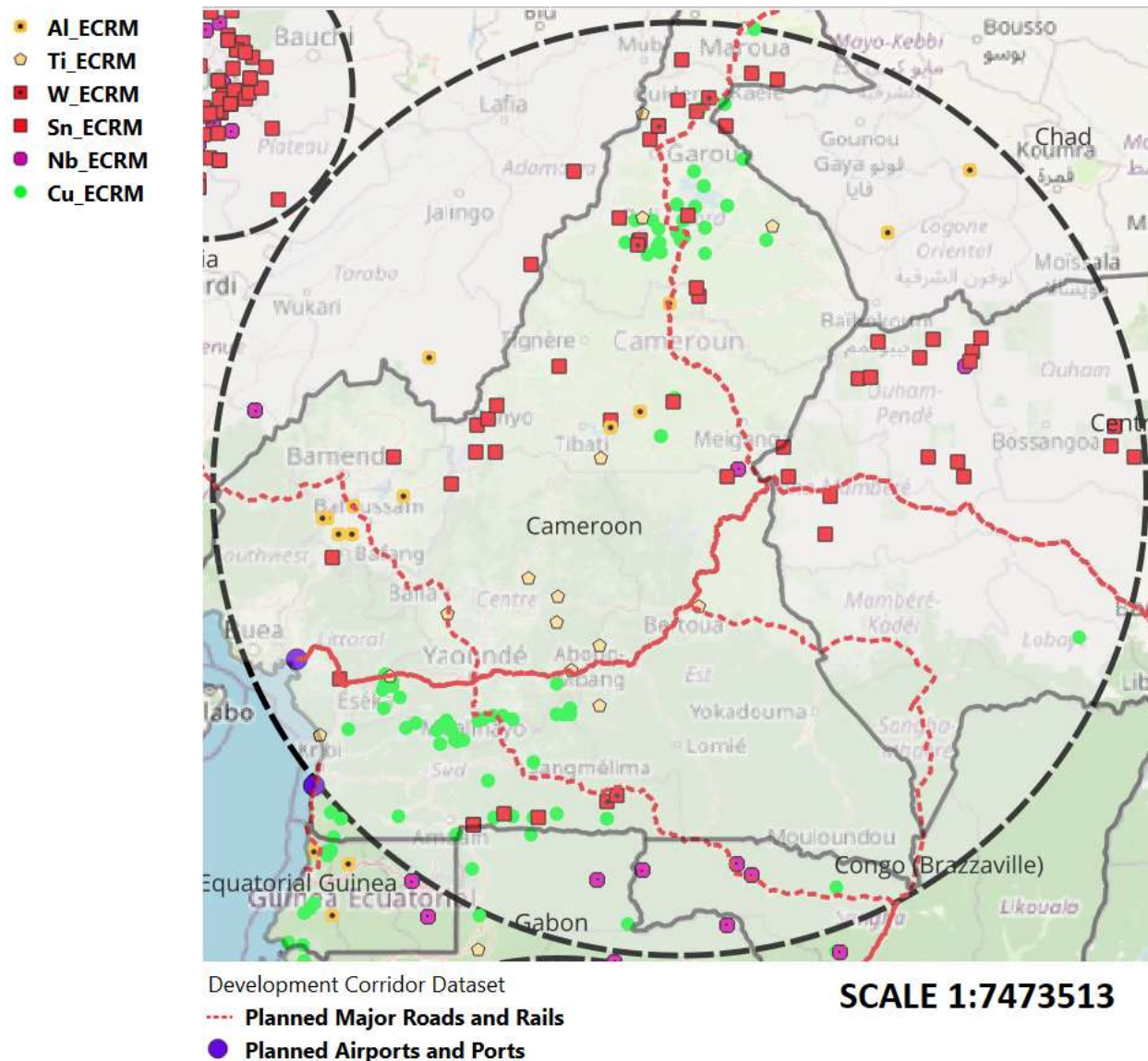


Figure 67 Location of Cluster 7: Western and Central Africa



### 7.7.2 Summary

Cluster 7 is especially rich in tin and copper occurrences, which span predominantly across Cameroon and Central African Republic. The region, however, faces many challenges associated with political instability. Road infrastructure in the cluster is adequately developed, whilst furthermore hosting six development corridor thoroughfares that are either completed or under construction. The mining landscape in the region of Cameroon, Republic of Congo and Nigeria is characterized by ASM activities, however some industrial mine sites exist. Processing infrastructure is scarce or unknown and would require investments to promote and support the development of potential ECRM projects. Take-off investments can therefore be made in exploration projects to help them reach production, as well as to strategically develop processing facilities to exploit ECRM occurrences with similar mineral structures. The vast road network in the region provides extensive access to the documented ECRM occurrences. It furthermore interacts with and supports the limited rail infrastructure, which in collaboration with the development corridors, form a solid transport foundation. Investments in the maintenance and management of major thoroughfares and the regions rail infrastructure may be crucial for the region's success. Investments in power generation (hydro) and/or distribution projects to support the take-off of ECRM projects will be necessary. The region's abundant hydro potential should be considered to help power isolated regions with high ECRM potential. Telecommunications are considerably developed in Cameroon, whereas investments in improving mobile coverage in Central African Republic may be necessary. Synergies are identified with the ongoing works of the African Development Bank (AfDB), the Governments of Cameroon and Central African Republic, and the EU. Cross-border development projects could interact with projects in cluster 6 and 9.

### 7.7.3 Assessment

**Main investment needs:** mining, processing, road, energy, communications.

|                              |                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as moderate in Cameroon and high in the Central African Republic. With respect to the African continent, Cameroon is ranked 42 <sup>nd</sup> and the Central African Republic 50 <sup>th</sup> of the 53-country dataset as of 2022. |
| Artisanal Small-Scale Mining | Relevant ASM producer countries for ECRM in this region are Cameroon, Republic of Congo, and Nigeria. ECRMs exploited via ASM practices include mainly tin, tantalum-niobium (coltan), and copper, beside non-ECRMs gold, diamonds, and gemstones.                                                                                                                                        |

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mining                         | <p>The mining landscape in Cameroon and Central African Republic remains in an infancy phase. Cameroon has notable deposits of iron ore, gold, bauxite, aluminium, cobalt, diamonds, copper, limestone, titanium, and nickel, not all of which are fully exploited. ASM activities are largely accountable for diamond and gold production in Central African Republic, however other mineral resources such as tin, niobium-tantalum, graphite, iron ore, copper, manganese, nickel, cobalt, chrome, graphite, uranium, limestone, and granite are yet to be exploited. Investments can be made to support ECRM exploration projects turning operational, as well as potentially turning ASM sites industrial.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Processing facilities          | <p>Available data identifies few active mineral processing facilities for cement, aluminium, diamond, gold, clay, limestone, and sand within the cluster. Of these, the aluminium smelter in Edéa, Cameroon, may be utilised. The limited processing infrastructure available is inadequate to support the ramp up of ECRM extraction in the area. This, together with the size of the cluster, the vast distribution of ECRM occurrences, and the diversity thereof, will require investments in local processing facilities to serve the region. Such investments will largely support the economic viability of many potential ECRM projects by reducing both capital expenditure and future transport costs.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Road / shipping infrastructure | <p>Road infrastructure in the cluster is well established. Primary (trunk) roads connect the regions northern and western hemispheres sufficiently and are adequately supplemented by secondary (national and regional) roads. As a result, the existing road network provides extensive coverage to the mapped ECRM occurrences. Primary road infrastructure provides nearby access to most ECRM occurrences in the cluster, whereafter shorter distances along secondary roads must be used to access potential project sites. Investments in the maintenance and improvement of primary and secondary roads will be important to manage the potentially large increase in freight traffic in the regions largely non-industrialised mining sector. The cluster furthermore contains six development corridor projects, namely the Lagos-Mombasa Highway (TAH-8), the Douala-Bangui Road, the Douala-N'djamena Road, the Yaounde-Doula Expressway, the Brazzaville-Yaounde Road, and the Tripoli-Windhoek-Cape Town Highway (TAH-3). The abundance of road infrastructure projects in the region will largely support the ramp up in ECRM extraction activities, whilst additionally expanding the cluster's primary road network to the southwest (TAH-3 and Brazzaville-Yaounde Road projects).</p> |

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rail infrastructure | <p>The cluster accommodates a single 1,100 km rail line from Nkongsamba to Ngaoundéré, linking the country's leading urban centres and facilitating economic and social connections with its neighbours. The railway is operated by Camrail and is used for both passenger and freight transport. Rail infrastructure connects the capital of Yaoundé with the port of Douala, whilst furthermore intersecting the TAH-3 and the Douala-N'djamena Road at its northern most station (Ngaoundéré). The EU and the European Investment Bank have recently (2022) invested € 123m in the modernisation of the 330 km rail segment (30 % of existing network) from Belabo to Ngaoundéré. The € 243m project is further supported by the Cameroonian government and the French development agency AFD, aiming to improve rail safety and efficiency, as well as to provide a sustainable alternative to road transport. In addition, construction works are underway of the Ntam-Kribi railway line, a 540 km railway project linking the north of the Republic of Congo with the port of Kribi in Cameroon. The project is estimated to cost US\$ 4.7bn, serving mining activities in the south and accommodating an annual capacity of 35 million t of ore. The current rail network, however, does not provide direct access to many of the mapped ECRM occurrences. Nevertheless, synergies with the development corridor highway projects will enable efficient freight transport in the region.</p> |
| Airports            | <p>The cluster hosts a vast distribution of airports, each varying in size, application, and capacity. Of these, only three international airports exist, namely Douala International Airport, Yaoundé Nsimalen International Airport, and Garoua International Airport; all of which are situated in Cameroon. These, however, are conveniently situated along existing transport corridors (rail and road) and may be used to for larger airfreight distribution throughout the cluster. Smaller, regional airports are broadly distributed and are typically close to mapped ECRM occurrences. Existing airport infrastructure, together with the extensive road network, should adequately serve the region.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Ports               | <p>The ports of Douala and Kribi in Cameroon directly serve the cluster. The Port of Douala has historically been the nation's leading seaport and continues to serve as a gateway to the Atlantic coast. Shallow waters and a lack of space, however, saw large investments flow in the deep-water port of Kribi, some 130 km to the south. In 2022, the port of Douala handled 47 % of container cargo into Cameroon, while the port of Kribi accounted for 53 %. Douala Port boasts freight storage facilities with a capacity of 25,000 m<sup>2</sup>. Furthermore, Maersk have recently invested in the construction of a 16,000 m<sup>2</sup> warehousing and distribution facility in Douala in a bid to aid cargo activities. The deep seaport of Kribi accommodates 140,000 m<sup>2</sup> of container storage facilities and 4,000 m<sup>2</sup> dedicated to warehouses. Both ports are currently undergoing expansion and upgrade works. Synergies exist with the terrestrial infrastructure, notably the existing and future railways at Douala and Kribi, respectively. The two ports should adequately serve the ECRM projects in the cluster.</p>                                                                                                                                                                                                                                                                                                                                    |

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|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Energy        | <p>Power stations are broadly spread throughout the cluster. Of these, merely four are characterised with generation capacities ranging between 100-1000 MW, three of which are located proximal to Cameroon's coast. Hydro power is harnessed at two of these plants along the Sanaga River. 17 power stations with generation capacities ranging between 10-100 MW are found within the cluster, the majority of which are powered by non-renewable sources. Smaller power stations with generation capacities &lt;10 MW are most abundant, most of which, however, are installed off grid. The power transmission network in the cluster is well-established along the Cameroonian coast and capital, as well as in the nation's north. Most of the cluster's power is distributed via high and medium voltage transmission infrastructure, although extra high voltage lines connect Kribi, Yaoundé, and Douala. Large areas within Cameroon and Central African Republic are, however, isolated from the grid, leaving many ECRM occurrences with no access to power.</p> <p>Cameroon boasts Africa's second largest hydroelectricity potential (20 GW), of which less than 5 % is currently exploited. Central African Republic similarly has a large hydroelectric potential. Investments in electrifying isolated areas with numerous ECRM occurrences may be important to help turn prospective projects operational.</p> |
| Communication | <p>Significant mobile network providers are MTN, Orange, Nexttel, and Yoomee in Cameroon, and Orange CAR, Telecel CAR, Moov Africa CAR, and Azur CAR in Central African Republic. Mobile network coverage in Cameroon is especially prominent in the hubs of Douala and Yaoundé, offering up to 4G+ services. Furthermore, mobile coverage up to 4G is found along major roadways within the nation. Mobile coverage in Central African Republic, however, is extremely limited, with scarce availability to 3G networks. Three fibre optic landing stations are found within the cluster, connecting to the West Africa Cable System (WACS), the South Atlantic 3 (SAT-3), and the Africa Coast to Europe (ACE) submarine fibre optic cables.</p> <p>Cameroon is currently extending its 15,000 km terrestrial fibre optic network by 3,500 km in a bid to capitalise on the lucrative information and communications technology potential. Investments of US\$ 36m from the African Development Bank (AfDB) and the EU have been made to support the Central African Republic's component of the Central Africa Fibre-Optic Backbone Project. The project includes 935 km of fibre optic cable connecting the nation with the Republic of Congo and Cameroon. Nevertheless, additional investments in telecommunications may be necessary to support isolated ECRM projects.</p>                                                 |

**Table 90 Infrastructure assessment of Cluster 7: Western and Central Africa**

## 7.8 Cluster 8: Coast of Red Sea

|                                                      |                                              |
|------------------------------------------------------|----------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 34,772395, Y 19,411722                     |
| Area estimated                                       | 1,360,000 km <sup>2</sup>                    |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Manganese, Tin, Tungsten, Phosphates |
| Country coverage                                     | Egypt, Sudan, Eritrea, Ethiopia              |

### 7.8.1 Location

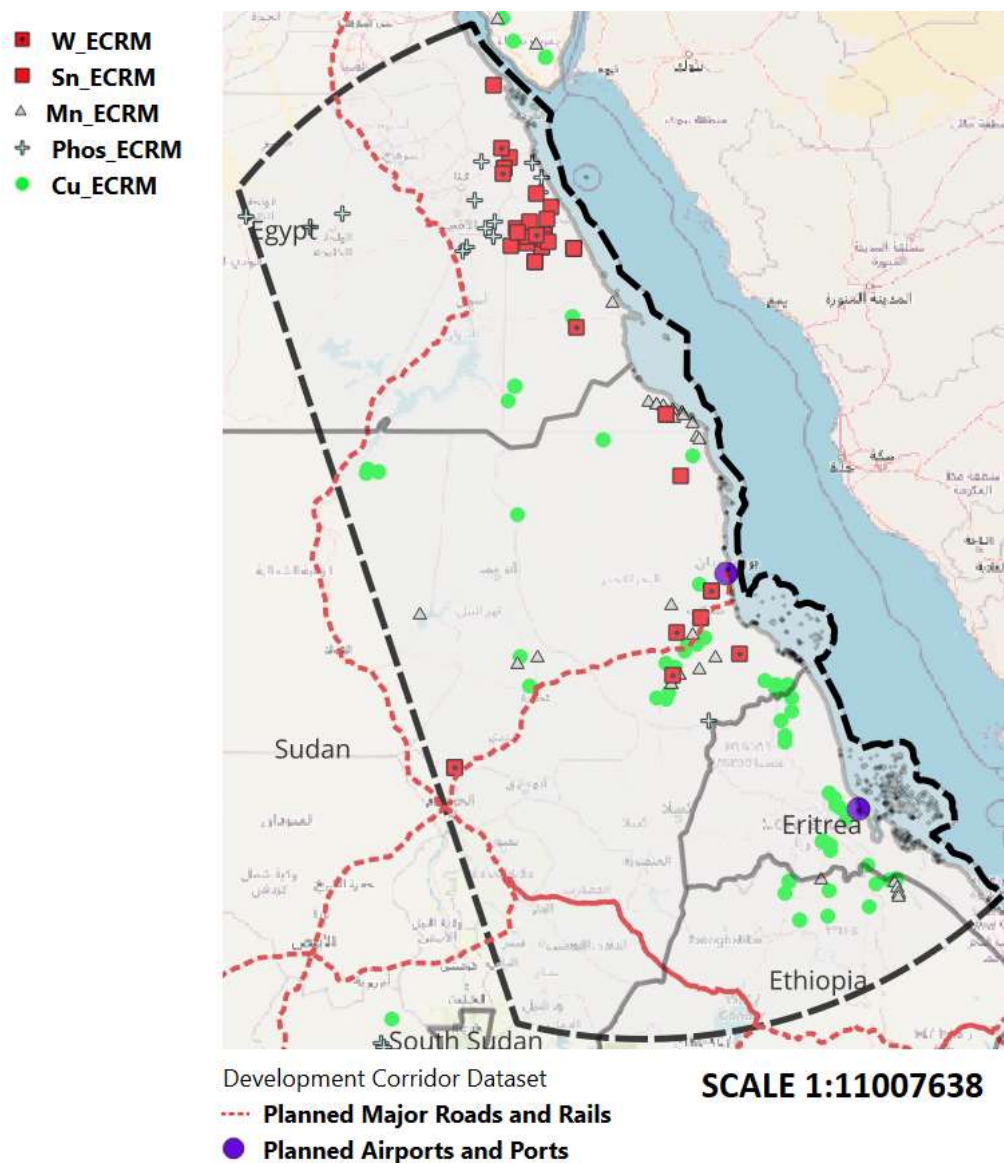


Figure 68 Location of Cluster 8: Coast of Red Sea

7.8.2 Summary

Cluster 8 is primarily made up of portions of Egypt, Sudan, and Eritrea and is especially rich in copper, manganese, and tin occurrences. The region varies in political stability. The cluster exhibits three operable development corridor thoroughfares that are either completed or still under construction. With the exception of Egypt, the industrial mining landscape in the cluster remains largely in an infancy stage. ASM is prevalent in Sudan and Ethiopia, where government policies and reforms in the latter are seeking to support the expansion of the sector. Processing infrastructure is not tailored for the region’s ECRMs and will require investments to promote and support the development of potential projects. Take-off investments can therefore be made in exploration projects to help them reach production, as well as to strategically develop processing facilities to exploit ECRM occurrences with similar mineral structures. Road infrastructure in the cluster is fragmented, with substantial developments in Egypt and Eritrea, connected by the less-developed road network in Sudan. Nevertheless, existing infrastructure well captures the documented ECRM occurrences. Business opportunities exist to streamline project to port thoroughfares (upgrading secondary road infrastructure), as well as to establish access roads to currently isolated ECRM occurrences. Rail infrastructure is well developed and together with current development projects, should well serve the cluster. Power in the region is well-sourced, though coverage to multiple ECRM hotspots is lacking. Investments in power distribution projects will therefore be necessary to support the take-off of ECRM projects. Telecommunications largely varies in quality throughout the region and is mostly limited to larger cities and development corridors in the region. Investments in improving mobile coverage and internet availability in Eritrea and Sudan will be important for the region’s prosperity. Key synergies are identified with the completed and ongoing works of the African Development Bank (AfDB), the United Nations Economic Commission for Africa (UNECA), the World Bank, the Governments of Egypt, Sudan, and Eritrea, as well as the private sector.

7.8.3 Assessment

**Main investment needs:** mining, processing, road, energy, communications.

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in Eritrea, moderate in Egypt, and high in Sudan and Ethiopia. With respect to the African continent, Eritrea is ranked 38 <sup>th</sup> , Egypt 39 <sup>th</sup> , Sudan 48 <sup>th</sup> , and Ethiopia 49 <sup>th</sup> of the 53-country dataset as of 2022. |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Artisanal Small-Scale Mining   | Ethiopia is a relevant ASM producer country for ECRM in Africa. ECRMs exploited via ASM practices include mainly niobium-tantalum (coltan) and minor PGEs, beside the non-ECRM gold.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Mining                         | Industrial mining is prevalent in Egypt, with ongoing projects in gold, tantalum/tantalite, copper, and industrial minerals. ASM activities dominate the Sudanese mining landscape, however large-scale mining in the Hassai Gold Mine produces gold, iron ore, and base metals. Similarly, commercial mining in Ethiopia remains in early stages, however gold, tantalite, potash, and coal mining operations exist. Mining in Eritrea is also in an infancy stage; however, the nation saw an influx of investment in the sector upon the re-opening of the Ethiopian border in 2018. Since then, commercial operations in gold, silver, copper, zinc, and potash have started, with many ongoing exploration programmes.                                                                                                                                                                                                                                                                                                                                       |
| Processing facilities          | Available data suggests that some 38 processing facilities exist within the cluster borders. Nevertheless, no processing facilities accommodate the ECRMs identified in the region. As such, investments in mineral processing facilities will be necessary to support the respective extraction activities. Larger capacity facilities should be considered (where possible) in locations with similar mineral occurrences.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Road / shipping infrastructure | The extent of road infrastructure development varies in each of the cluster's countries. Primary (trunk) roads connect the region sufficiently, especially in its northern and southern poles, and are supplemented well by secondary (national and regional) road infrastructure. Although partially limited (Sudan), the current road network well serves the documented ECRM occurrences, however, several remain inaccessible. The cluster contains three development corridor road projects within it, namely the Cairo–Gaborone–Cape Town Road (TAH-4), the Djibouti–N'Djamena Highway (TAH-6), and the Juba–Port Sudan Road. These highways are critical to the region; however, portions remain unsealed. Nevertheless, given the coastal proximity of many of the ECRM occurrences in the cluster, investments may rather be sourced into streamlining project to port thoroughfares (upgrading secondary road infrastructure), as well as establishing access roads to currently isolated occurrences (e.g., coastal region between Eritrea and Sudan). |

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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| Rail infrastructure | <p>The cluster boasts ample rail infrastructure, not all of which serves the regions ECRM occurrences. Rail infrastructure in Sudan, however, lies conveniently close to many of the nation's mapped occurrences, while simultaneously providing a direct link to Port Sudan. On the contrary, rail infrastructure in Eritrea is limited. The single railway connects Asmara with the Port of Massawa and may mildly serve potential ECRM project in the region. Rail infrastructure in Egypt spans into the cluster area, however, does not serve near-lying ports. Large investments in rail infrastructure (US\$ 23bn), however, will see the construction of the Luxor-Safaga line (line 3), connecting the cluster area with the Port of Safaga. Together with existing road infrastructure, current and planned rail infrastructure should adequately serve the region.</p> |
| Airports            | <p>The cluster hosts numerous international airports, namely Assiut International Airport, Hurghada International Airport, Luxor International Airport, and Suhag International Airport in Egypt; Port Sudan International Airport in Sudan; and Massawa International Airport in Eritrea. Smaller, regional airports are distributed more broadly throughout the cluster. Given the coastal proximity of the cluster and especially the respective international airports, material can be transported for import/export by ship or plane. Imported materials can be locally re-directed by rail or road infrastructure.</p>                                                                                                                                                                                                                                                     |
| Ports               | <p>There are currently four major ports serving the cluster region: Hamrawein Port and Port Safaga in Egypt, Port Sudan in Sudan, and the Port of Massawa in Eritrea. United Arab Emirates company AD Ports Group recently invested US\$ 200m to develop and operate a new port terminal in Safaga. Furthermore, the UAE investment group signed a preliminary agreement with Sudan in 2022 to build and operate the Abu Amama Port and Economic Zone on the Red Sea worth US\$ 6bn. The breakout of a civil war in 2023, however, has suspended economic activities and especially foreign investment in the region. The project would not only relieve Port Sudan but may also serve the numerous ECRM occurrences along Sudan's northern coastline. The numerous port facilities in the cluster should sufficiently serve potential ECRM projects.</p>                         |
| Energy              | <p>The regions power generation infrastructure is well-established. There are three large-scale power stations with generation capacities exceeding 1000 MW within the cluster, two of which harness renewable sources (hydro). This is supplemented by multiple smaller plants with varying generation capacities ranging between 100-1000 MW, 10-100 MW, and &lt;10 MW, respectively. Many of the clusters power stations are located along the Nile River, exploiting the regions hydroelectrical potential. Power in the region is also generated by means of solar, wind, biomass, and non-renewable sources. Many of the clusters ECRM occurrences, however, currently have no access to power due to a lack of power transmission infrastructure. Investments in expanding the power transmission network can be made to connect ECRM rich areas to the grid.</p>          |

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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| Communication | Significant mobile network providers in the cluster are Vodafone Egypt, Orange Egypt, Etisalat Egypt, and WE (Telecom Egypt) in Egypt; MTN Mobile, Sudatel Mobile, and Zain Mobile in Sudan; and Eritrea Telecom (Eritel) and RedSea (TMH Telecom) in Eritrea. Mobile network services are available up to 4G+, however coverage is limited in the cluster area. Fibre optic landing stations are found in both Egypt and Sudan within the cluster. Eritrea is the only coastal country in the continent without a submarine cable landing. Egypt has been undergoing considerable digital transformations, with investments of US\$ 342.6m committed to developing telecoms infrastructure and a further US\$ 1.3bn to the build out of the fibre optic network. Nevertheless, the terrestrial fibre optic network in the cluster is scarce, especially in Eritrea and Sudan. Investments in telecommunications in the cluster, especially in Sudan and Eritrea, will be necessary to improve mobile coverage and internet access in the region. |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Table 91 Infrastructure assessment of Cluster 8: Coast of Red Sea

## 7.9 Cluster 9: Central African Coast (West)

|                                                      |                                                                           |
|------------------------------------------------------|---------------------------------------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 12,392350, Y -2,520448                                                  |
| Area estimated                                       | 465,000 km <sup>2</sup>                                                   |
| Predominant ECRM occurrences (prospecting – deposit) | Aluminium, Copper, Niobium-Tantalum, Manganese, Tin, Tungsten, Phosphates |
| Country coverage                                     | Gabon, Republic of the Congo, Democratic Republic of the Congo, Angola    |

### 7.9.1 Location

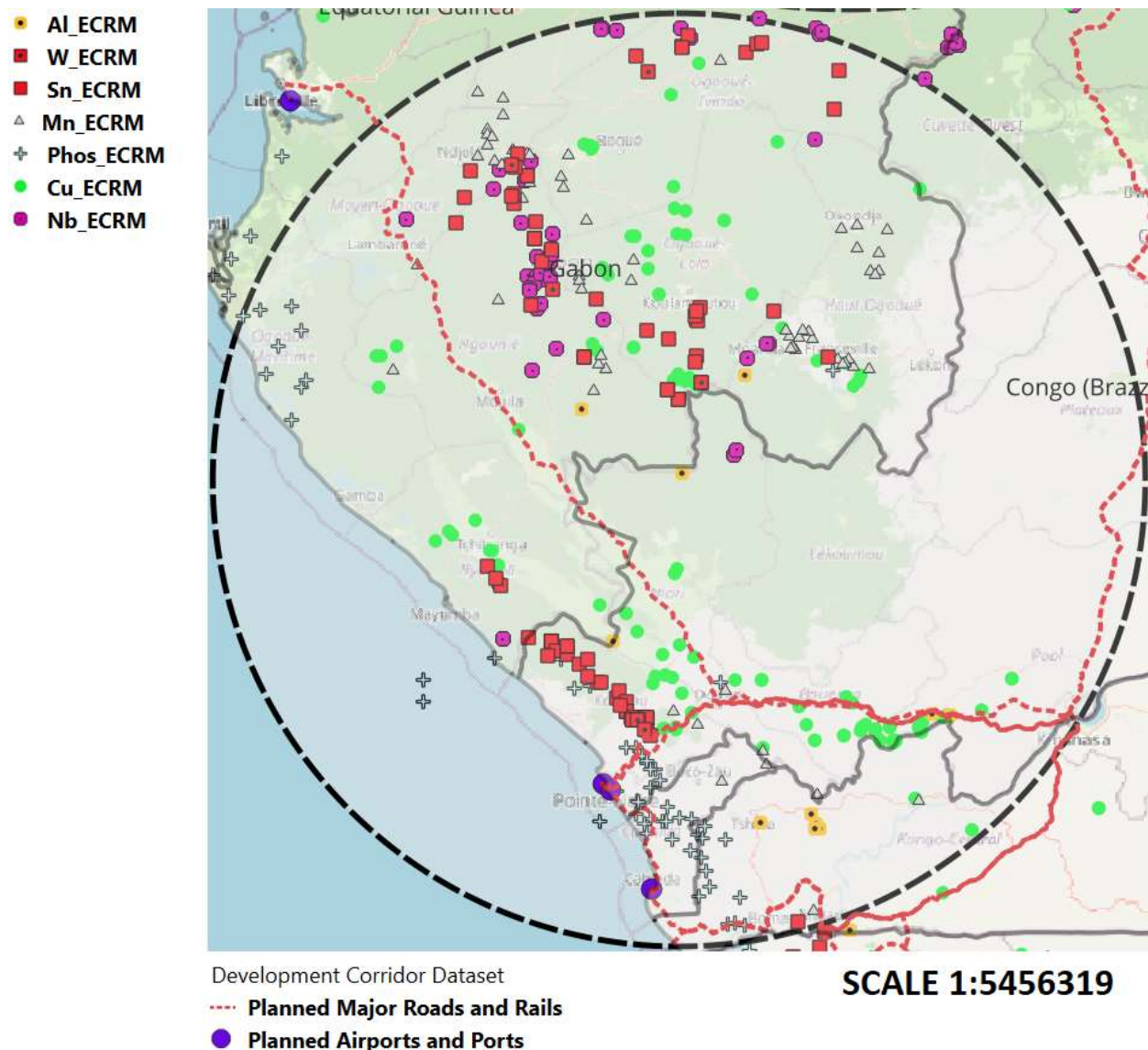


Figure 69 Location of Cluster 9: Central African Coast (West)

7.9.2 Summary

Cluster 9 is largely represented by Gabon and the Republic of the Congo, with smaller fragments of Angola and the Democratic Republic of the Congo. The region is especially rich in copper, niobium-tantalum, manganese, tin, and phosphate occurrences. The region is predominantly politically stable. The cluster exhibits six operable development corridor thoroughfares that are either completed or still under construction. The mining landscape in Republic of Congo and DRC is dominated by ASM activities, however commercial sites exist. Processing infrastructure accommodates large-scale projects, however, generally remains in an infancy stage. Given the region’s high ECRM concentration and diversity, investments will be necessary to promote and support the development of potential projects. Take-off investments can therefore be made in exploration projects to help them reach production, as well as to strategically develop processing facilities to exploit ECRM occurrences with similar mineral structures. Road infrastructure in the cluster is limited, especially with respect to the documented ECRM occurrences. Investments will therefore be necessary to establish access roads to currently isolated ECRM occurrences. Rail infrastructure consists of the two national lines in Gabon and the Republic of the Congo (both undergoing modernisation), which provide moderate coverage throughout the cluster. However, current infrastructure grants direct or nearby access to multiple ECRM occurrences. Rail expansion projects may therefore be lucrative for the cluster. Current port infrastructure and the associated development/upgrade projects should adequately serve the region. Power infrastructure in the region is heavily polarised. Adequate infrastructure exists in the regions south, however, much of the cluster area and many ECRM hotspots remain isolated from the grid. Investments in power generation and distribution projects will therefore be necessary to support the take-off of ECRM projects. Telecommunications largely varies in quality throughout the region and is mostly limited to larger cities and development corridors in the region. Investments in improving mobile coverage and internet availability in the cluster will be important for the region’s prosperity. Key synergies are identified with the completed and ongoing works of the African Development Bank (AfDB), the United Nations Economic Commission for Africa (UNECA), the Governments of Gabon and the Republic of Congo, as well as the private sector. Cross-border development projects could interact with projects in cluster 7.

7.9.3 Assessment

**Main investment needs:** mining, processing, road, rail, energy, communications.

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|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in Gabon, the Republic of the Congo, and Angola, and moderate in the Democratic Republic of the Congo (DRC). With respect to the African continent, Gabon is ranked 8 <sup>th</sup> , Republic of the Congo 11 <sup>th</sup> , Angola 30 <sup>th</sup> , and DRC 47 <sup>th</sup> of the 53-country dataset as of 2022. |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Artisanal Small-Scale Mining   | <p>Relevant ASM producer countries for ECRM in Africa are Republic of Congo and DRC, although the DRC's significant ASM activities are not happening within or near the cluster. ECRMs exploited in Republic of Congo via ASM practices include mainly tantalum-niobium (coltan) and copper beside non-ECRMs gold, diamonds, lead, and zinc. In DRC cobalt, copper, rare earth elements, tantalum-niobium, tin, tungsten, in few areas PGE as well as additional non-ECRMs mainly gold, diamonds and tourmaline are exploited.</p>                                                                                                                                                                                                                                                                                                                                                                                                             |
| Mining                         | <p>Commercial mining in the cluster is largely underdeveloped with respect to the abundant mineral resources. Gabon has several large-scale mining operations, including the extraction of manganese, niobium-tantalum, rare earth oxides, and iron ore. Republic of the Congo currently exploits potash and phosphate, while disputes over tenure agreements are halting iron ore projects from becoming operational. In the Democratic Republic of the Congo, industrial mining operations in copper, cobalt, diamonds, and gold are found outside of the cluster. However, value chains from these operations will later interact with infrastructure within the cluster, e.g., Angolan ports, upon the completion of the Lobito Corridor Project. Angola hosts a diverse range of commercial operations, where diamonds, iron ore, phosphate, manganese, rare earth elements (REE), and gold are presently exploited.</p>                  |
| Processing facilities          | <p>In line with the regions underdeveloped large-scale mining industry, processing facilities are similarly limited in the cluster. Processing facilities accommodate the respective commodities of large-scale operations (gold, manganese, diamonds), as well as for industrial minerals (cement). Given the cluster's vast and diverse ECRM occurrences, investments in processing facilities will be necessary. Considerations should be made to areas with high densities of similar mineral occurrences (e.g., tin belt along the Republic of the Congo's coast, phosphate occurrences in Angola, niobium-tantalum cluster in Gabon, etc.) such that larger facilities can handle throughput from multiple projects (where possible).</p>                                                                                                                                                                                                |
| Road / shipping infrastructure | <p>Road infrastructure is considerably limited in the cluster. Isolated stretches of primary (trunk) road infrastructure are found in Gabon, the Republic of the Congo, and the Democratic Republic of the Congo. These are moderately supplemented by secondary (national and regional) roads, leaving many of the cluster's ECRM occurrences inaccessible. Several development corridor highways intersect the cluster, including the Brazzaville-Pointe Noire-Libreville Road, the Pointe Noire – Cabinda Road, the Luanda-Cabinda Road, and the Tripoli-Windhoek-Cape Town Highway (TAH-3), all of which are currently operational yet not all complete. Nevertheless, these projects only mildly serve the vast ECRM occurrences mapped in the region. As such, investments in adequate road infrastructure (combination of sealed and unsealed roads) in ECRM rich areas will be necessary to fully harness the cluster's potential.</p> |



|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rail infrastructure | <p>Rail infrastructure in the cluster consists of the two national rail lines in Gabon and Republic of the Congo, namely the Trans-Gabon Railway and the Congo-Ocean Railway. These link the region with the port cities of Owendo (Gabon) and Pointe Noire (Republic of the Congo) and provide decent coverage throughout the cluster. The railways furthermore provide direct or nearby access to multiple ECRM occurrences. The Trans-Gabon Railway runs in a single stretch from the Port of Owendo in Libreville to Franceville and since 2015 has been subject to a € 706m modernisation, renovation, and upgrade programme in a bid to raise capacity to 19 million t per annum. Similarly, large investments (US\$ 1.08bn) have flooded into the Republic of Congo to construct a 412 km line to serve the iron ore rich area in the Niari region and to rehabilitate the 182 km Mbinda-Mont Mbelo line. Investments in extending rail infrastructure from existing lines (i.e., branches) to capture and connect ECRM rich areas with port cities may be lucrative for the cluster.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Airports            | <p>The cluster region is host to four international airports, namely M'Vengue El Hadj Omar Bongo Ondimba International Airport (Franceville, Gabon), Antonio Agostinho-Neto International Airport (Pointe Noire, Republic of the Congo), Boma International Airport (Boma, Democratic Republic of the Congo), and Maya-Maya International Airport (Brazzaville, Republic of the Congo). These are supplemented by a vast amount of small, regional airports and should adequately serve the region. Investments were previously made in constructing a new terminal at the Antonio Agostinho-Neto International Airport (2015).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Ports               | <p>There are currently four major ports serving the cluster region: the port of Cabinda (Angola), the port of Pointe Noire (Republic of the Congo), the port of Owendo (Gabon), and Port Gentil (Gabon). The two former ports are located within the cluster's boundaries, whereas the port of Owendo and Port Gentil service the region externally. Rail infrastructure efficiently links the more significant Gabonese port of Owendo with the cluster region, while Port Gentil is accessible by road. Construction of the Democratic Republic of Congo's US\$ 1.2bn deep-water Banana Port (financed by DP World, Dubai) began in 2022, despite the criticism it faced regarding its proximity to protected wetlands. AD Ports have furthermore secured a 30-year concession agreement with the Government of the Republic of the Congo for developing, operating, managing, and maintaining the New East Mole Terminal in Pointe-Noire. This includes an investment of approximately US\$ 500m throughout the concession period. In 2019, the Gabon Special Economic Zone secured a € 305m debt finance from the Emerging Africa Infrastructure Fund (EAIF) to develop new facilities at the port of Owendo in the capital Libreville. Similarly, substantial investments to upgrade the port of Cabinda and to construct the nearby Caio deep-water port in Angola (within the cluster) will largely benefit the region. Port infrastructure in the region, as well as the ongoing infrastructure projects, should adequately serve the cluster.</p> |

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Energy        | <p>The regions power generation infrastructure is moderately established. There is one large-scale hydropower station with a generation capacity exceeding 1000 MW within the cluster. This is supplemented by multiple smaller plants with varying generation capacities ranging between 100-1000 MW, 10-100 MW, and &lt;10 MW, respectively. Many of the medium to large-scale power plants (10-1000 MW) harness hydro power, with some exceptions in non-renewable fuels. Small off-grid plants are most vastly distributed throughout the cluster, most of which use diesel or other non-renewables to generate power. Nearly all of the 20 medium to large-scale plants connect to the grid, most of which are situated in the cluster's southern and southeastern region. Accordingly, the grid network is largely polarised in the cluster, with vast expanses having no access to reliable and stable power. As such, many of the cluster's ECRM occurrences currently have no access to power. Investments in developing the grid network (i.e., construction of power stations and transmission lines) in ECRM rich areas will be necessary for the success of the cluster.</p>                                                                                                           |
| Communication | <p>Significant mobile network providers in the cluster are MOOV Africa and Airtel in Gabon; MTN, Airtel, AZUR, and Congo Telecom in the Republic of the Congo; Airtel, Vodacom, Tigo, Orange, and Africell in the Democratic Republic of the Congo; and Africell, Movitel, and Unitel in Angola. Mobile network services are available up to 5G, however coverage is limited in the cluster area and mostly limited to larger cities or along development corridors. Fibre optic landing stations are found in all the cluster's countries. These stations plug into to the Libreville-Port Gentil Cable, Africa Coast to Europe (ACE), and the SAT-3/WASC cables in Gabon; the West African Cable System (WACS) in the Republic of the Congo; the Angola Domestic Network System (ADONES) in Angola; and the Africa Coast to Europe (ACE) and the West African Cable System (WACS) in the Democratic Republic of the Congo. The Central African Backbone project has seen the development of terrestrial cables in Gabon, the Republic of the Congo, and the Democratic Republic of the Congo, however coverage in the cluster remains scarce. Investments in telecommunications infrastructure in the cluster will be necessary to improve mobile coverage and internet access in the region.</p> |

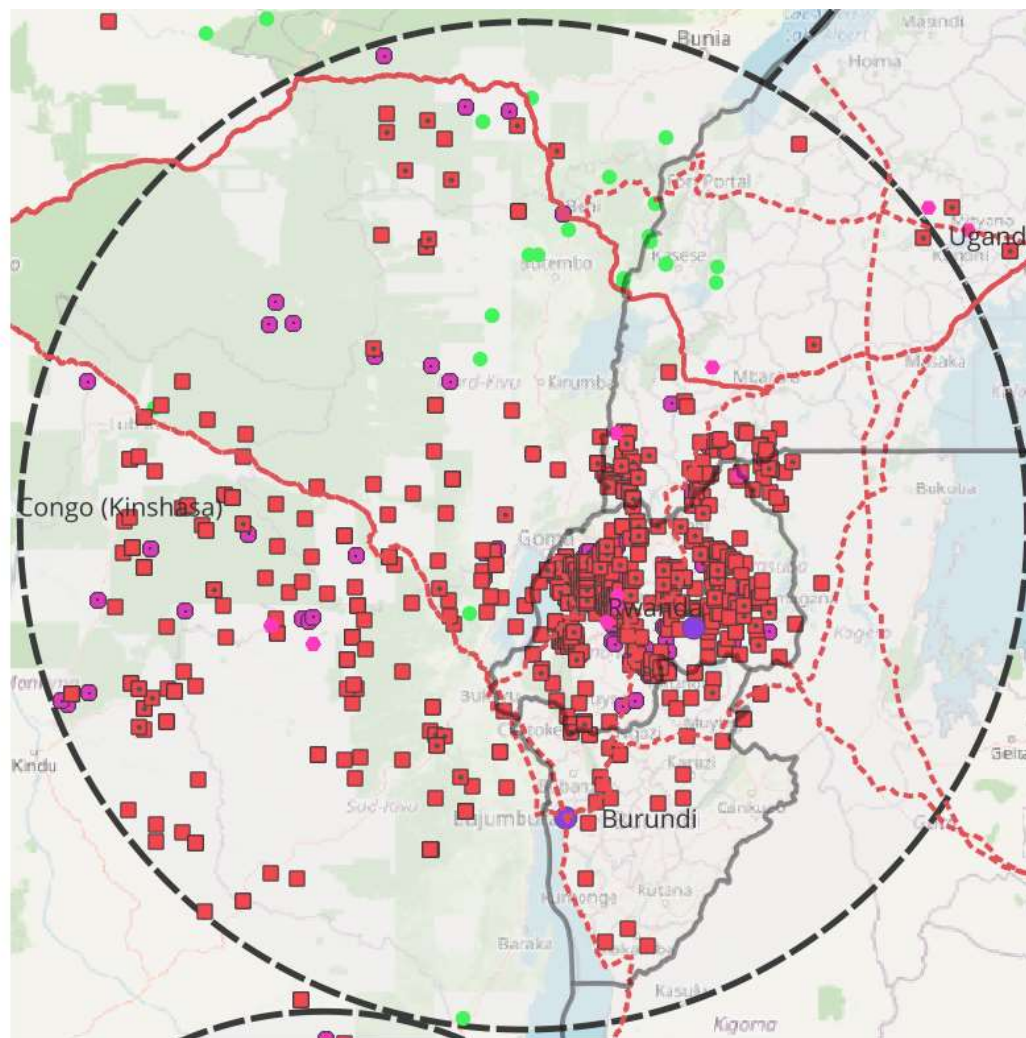
**Table 92 Infrastructure assessment of Cluster 9: Central African Coast (West)**

## 7.10 Cluster 10: Central and Eastern Africa

|                                                      |                                                                 |
|------------------------------------------------------|-----------------------------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 29,075915, Y -1,482556                                        |
| Area estimated                                       | 410,000 km <sup>2</sup>                                         |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Niobium-Tantalum, Lithium, Tin, Tungsten                |
| Country coverage                                     | Democratic Republic of Congo, Uganda, Rwanda, Burundi, Tanzania |

### 7.10.1 Location

- Li\_ECRM
- W\_ECRM
- Sn\_ECRM
- Cu\_ECRM
- Nb\_ECRM



Development Corridor Dataset

--- Planned Major Roads and Rails

● Planned Airports and Ports

SCALE 1:5260179

Figure 70 Location of Cluster 10: Central and Eastern Africa

### 7.10.2 Summary

Cluster 10 is especially rich in tin, tungsten, and niobium-tantalum occurrences, which are most heavily concentrated in Rwanda and Burundi. The region is mostly considered political stable. Road infrastructure in the cluster is moderately developed and largely fragmented. The cluster exhibits six development corridor thoroughfares that are either completed or under construction. The mining landscape in the whole region of the cluster is dominated by ASM activities, however some industrial sites exist. Processing infrastructure is limited and will require investments to promote and support the development of potential ECRM projects. Take-off investments can therefore be made in exploration projects to help them reach production, as well as to strategically develop processing facilities to exploit ECRM occurrences with similar mineral structures. The road network in the region's eastern hemisphere provides extensive access to the documented ECRM occurrences. It furthermore interacts with external rail infrastructure in Uganda and Tanzania, which in collaboration with the development corridors, provide multi-modal links to the port cities of Dar es Salaam and Tanga in Tanzania, and Mombasa in Kenya. Due to the cluster's dependence on road infrastructure, investments in the maintenance and management of major thoroughfares will be crucial for the region's success. Furthermore, investments in developing new roadways in the DRC will especially be important for the success of ECRM projects in the less developed western hemisphere of the cluster. Due to the high concentration of ECRM occurrences in the cluster, considerations into developing a regional rail network linking into existing rail infrastructure in neighbouring countries should be made. Investments in power generation (hydro) and/or distribution projects to support the take-off of ECRM projects will be necessary. The region's hydro potential is already abundantly exploited in the clusters east, although the power distribution network remains comparably underdeveloped. Furthermore, the cluster's western hemisphere significantly lacks access to power. Investments in both power generation and distribution infrastructure will therefore be necessary for the success of potential ECRM projects in the region. Telecommunications are largely limited to larger cities in the region. As such, investments in improving mobile coverage and internet availability will be necessary. Key synergies are identified with the completed and ongoing works of the African Development Bank (AfDB), the United Nations Economic Commission for Africa (UNECA), the World Bank, and the Government of Rwanda. Cross-border development projects could interact with projects in cluster 11, 12 and 16.

### 7.10.3 Assessment

**Main investment needs:** mining, processing, road, rail, energy, communications.

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|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in Rwanda, Tanzania, and Uganda, and moderate in Burundi and the Democratic Republic of the Congo (DRC). With respect to the African continent, Rwanda is ranked 10 <sup>th</sup> , Tanzania 20 <sup>th</sup> , Uganda 34 <sup>th</sup> , Burundi 40 <sup>th</sup> , and DRC 47 <sup>th</sup> of the 53-country dataset as of 2022.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Artisanal Small-Scale Mining | Relevant ASM producer countries for ECRM in Africa are all countries covered by this cluster: Democratic Republic of Congo, Uganda, Rwanda, Burundi, and Tanzania, although Tanzania is only partially covered by the cluster. ECRMs exploited via ASM practices include cobalt, copper, rare earth elements, tantalum-niobium, tin, tungsten, in few areas PGE as well as additional non-ECRMs mainly gold, diamonds, and tourmaline are exploited.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Mining                       | The cluster contains numerous active mining activities mostly concentrated in Rwanda and Burundi. ASM dominates the mining landscape in the region, however efforts are being made to formalise the sector to attract private investment and consequently increase the scale of production. Mechanised, larger-scale operations in tin, tungsten, and tantalum extraction do however exist in Rwanda. On the contrary, the industrialisation of Burundi's mining industry remains in largely in an infant state. Industrial mining activities are more common in the DRC, Tanzania, and Uganda, although this is not representative in the cluster region. Investments can be made to support ECRM exploration projects turning operational.                                                                                                                                                                                                                                                                                                       |
| Processing facilities        | Few mineral processing facilities exist within the cluster, most of which are situated in Rwanda (tin, cement, stone, iron ore, and tourmaline). Rwanda is furthermore home to two refineries of gold and tin, each with large capacities to handle throughput from numerous operations in the region. This is particularly relevant for the vast tin occurrences found especially within Rwanda, but also in neighbouring countries nearby. Given the high concentration of ECRM occurrences in the cluster, investments in mineral processing facilities will be necessary to accommodate mining activities. Such investments will have considerable internal and downstream effects, such as boosting local economies, increasing the value of inland products, and reducing transportation costs. Considerations should be made to areas with high densities of similar mineral occurrences (e.g., tin, tungsten, and niobium-tantalum in Rwanda) such that larger facilities can handle throughput from multiple operations (where possible). |



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| Road / shipping infrastructure | <p>Road infrastructure is fragmented throughout the cluster. Primary (trunk) roads are solely found in the cluster's eastern hemisphere (Uganda, Rwanda, Burundi, and Tanzania) and is most prominent in Rwanda. Centralised in Rwanda, the primary road network links the nation with Uganda, Tanzania, and Burundi, and ultimately provides access to larger cities and ports to the east. This albeit scarce primary road network is heavily supported by the secondary (national and regional) road network, especially in the cluster's eastern hemisphere. The immense density of ECRM occurrences in this portion of the cluster ensures that many sites are almost accessible, although investments will be necessary to provide full and reliable access. Such investments should take the cluster's respective development corridor projects into consideration in order to link ECRM projects to important transport thoroughfares. The development corridors found within the cluster include the Northern Corridor Transportation Improvement Road, the North-South Corridor Road, the Bangui-Kisangani-Bujumbura-Kampala Road, the Central Development Corridor Highway, the Lagos-Mombasa Highway (TAH-8), and the Kampala-Mbarara-Kisangani Road. Road infrastructure in the DRC's portion of the cluster is extremely limited. Together with the broad distribution of ECRM projects in the cluster's western hemisphere, many ECRM projects remain isolated. Investments in road infrastructure will therefore be vitally important to projects in the DRC, where links to the Northern Corridor Transportation Improvement Road and the Bangui-Kisangani-Bujumbura-Kampala Road should especially be sought after.</p> |
| Rail infrastructure            | <p>The cluster currently contains no rail infrastructure. Investments in rail infrastructure may be lucrative due to the region's extraordinary ECRM potential. Existing rail infrastructure in Uganda, Kenya, and Tanzania connects the respective nations with multiple port cities (Mombasa, Tanga, Dar es Salaam). As such, opportunities exist to construct railways within the region to marry up with the existing near-lying infrastructure in Tanzania and Uganda. Existing development corridors – the North-South Corridor Road; the Bangui-Kisangani-Bujumbura-Kampala Road; the Lagos-Mombasa Highway; the Central Development Corridor Highway; and the Northern Corridor Transportation Improvement Road – currently provide access to these rail networks and may be used as a guide for potential rail development in the cluster.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Airports                       | <p>The cluster region is host of two international airports, namely Kigali International Airport (Kigali, Rwanda) and Melchior Ndadaye International Airport (Bujumbura, Burundi). Construction of the US\$ 2bn Bugesera International Airport (Bugesera, Rwanda) is currently underway and includes the construction of a cargo terminal capable of accommodating 150,000 t of cargo annually. The new airport is expected to be completed by 2026. The cluster's international airports are supplemented by multiple small, regional airports that should adequately serve the region. Nevertheless, investments in small airports in the cluster's northwest may be beneficial pending the profitability and scale of potential ECRM projects in the region.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |



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| Ports  | <p>No seaport facilities are contained within the cluster. Seaports accessible to the cluster include the ports of Mombosa (Kenya), Tanga (Tanzania), and Dar es Salaam (Tanzania). Access to these ports is granted by existing road (development corridor) and rail (external) infrastructure. Nevertheless, the port of Bukoba (Tanzania) is contained within the cluster and serves shipping transport through Lake Victoria. The sole route from Bukoba leads to the port of Mwanza (Tanzania), where rail infrastructure creates a link to the ports of Dar es Salaam and Tanga. This transport route may be considered to relieve the road network; however, transport efficiencies and costs will be subject to evaluation. The port of Mombosa has recently seen large investments for the expansion of its container terminals, the automation of services, and the acquisition of new equipment. Similarly, the Tanzanian Ports Authority recently signed a 30-year concession agreement with Dubai's logistics multinational DP World to upgrade the port of Dar es Salaam. This includes an initial investment of US\$ 250m during the first phase, and an overall projection of US\$ 1bn. Furthermore, the US\$ 170m project for the renovation and upgrading of the port of Tanga was recently completed in 2023. In light of their recent developments, the numerous ports should well serve the cluster.</p>                                                                                                                                                                                                                                                                                                                                                                             |
| Energy | <p>Power generation infrastructure in the cluster is mostly concentrated in Rwanda, with some exceptions in Uganda and Burundi. The largest power plants in the region have generation capacities ranging between 10-100 MW, most of which are connected to the grid. The power network is supplemented by many smaller power stations (&lt;10 MW), some as satellite installations (off-grid), however mostly on-grid. Hydropower is heavily exploited in the region, with ten of the 17 larger plants and 63 of the 80 smaller plants harnessing this energy source. Power is distributed by means of high and medium voltage distribution lines in Rwanda, Uganda, and Tanzania. In Burundi, only medium voltage distribution lines are currently available. Power distribution infrastructure in the DRC fraction of the cluster is non-existent, except for an isolated high voltage installation in the southwest. Accordingly, the energy network (plants and distribution systems) in the cluster is heavily polarised. Rwanda, Uganda, Burundi, and Tanzania have well-established power networks, especially with respect to the documented ECRM occurrences, whereas the DRC in the cluster's western hemisphere majorly lacks power infrastructure. The homogenous distribution of ECRM occurrences in the DRC, together with the nations sheer size, poses a complex problematic. However, considerations could be made to create a power generation and transmission backbone to connect existing power infrastructure in the cluster's southwest with its central region (Rwanda), with strategic branches to capture most of the DRCs ECRM occurrences. An expansion of the power distribution network in Rwanda, Burundi, and Uganda may also be beneficial to the ECRM rich region.</p> |

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| Communication | <p>Significant mobile network providers in the cluster are MTN Mobile and Airtel in Rwanda; Econet, Lumitel, Onatel, and Smart Mobile in Burundi; Airtel, Vodacom, Tigo, Orange, and Africell in the DRC; Vodacom, Airtel, Tigo, and Halotel in Tanzania; and Africell, Airtel, MTN, and UTL in Uganda. Mobile network services are available up to 4G+, however coverage is limited in the cluster area and mostly limited to larger cities or along development corridors. Being the cluster’s sole coastal nation, Tanzania is the only country with access to the submarine fibre-optic network. The landing station located at Dar es Salaam connects to the Seychelles to East Africa System (SEAS), Djibouti Africa Regional Express (DARE), Africa-1, Eastern Africa Submarine System (EASSy), Liquid Sea, and the SEACOM/Tata TGN-Eurasia fibre-optic cables. The terrestrial fibre-optic network in the cluster is well-developed in Rwanda, Burundi, Tanzania, and Uganda, while the development of infrastructure projects remains ongoing in the DRC. Investments in telecommunications infrastructure in the cluster will be necessary to improve mobile coverage and internet access in the region, particularly in the DRC.</p> |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

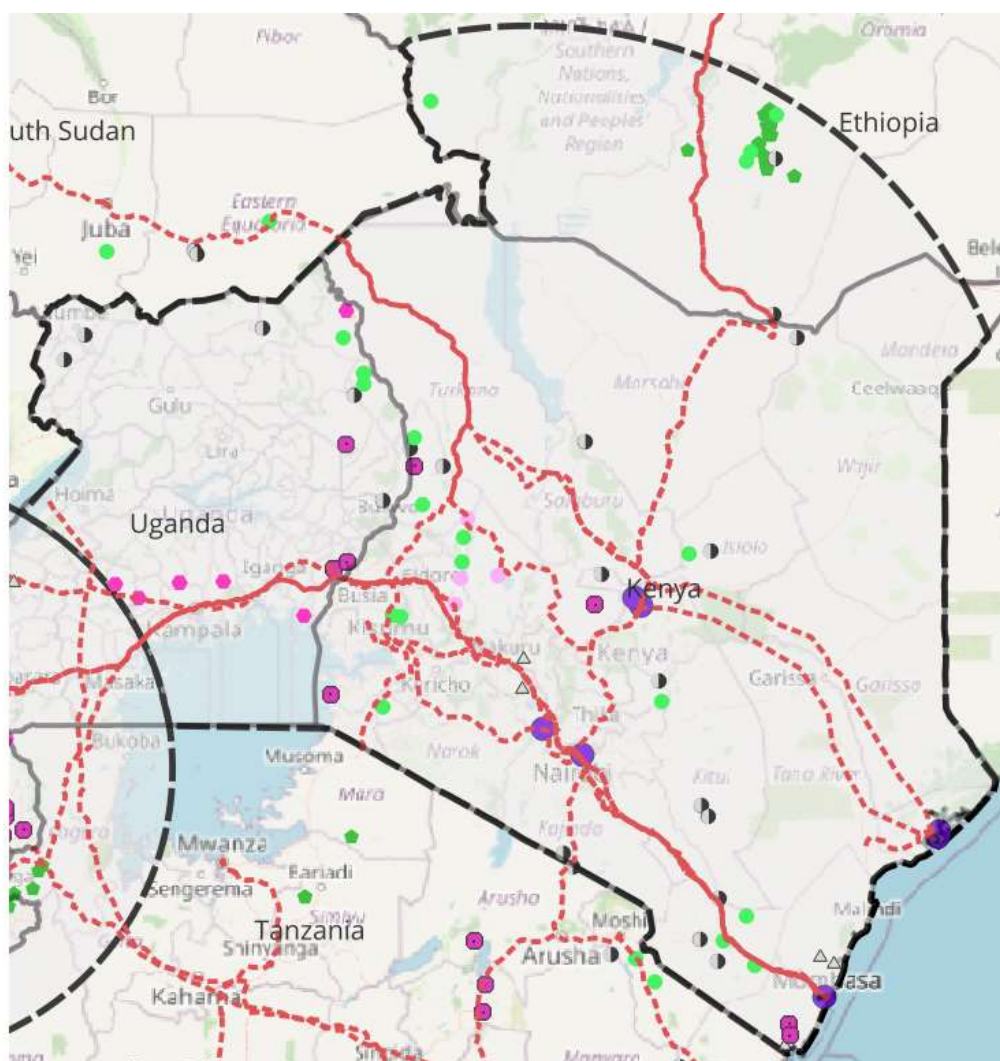
**Table 93 Infrastructure assessment of Cluster 10: Central and Eastern Africa**

## 7.11 Cluster 11: Eastern Africa (North)

|                                                      |                                                                          |
|------------------------------------------------------|--------------------------------------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 36,849545, Y 1,545968                                                  |
| Area estimated                                       | 927,560 km <sup>2</sup>                                                  |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Graphite, Niobium-Tantalum, Lithium, Manganese, Nickel, Fluorite |
| Country coverage                                     | Uganda, Ethiopia, Kenya                                                  |

### 7.11.1 Location

- Li\_ECRM
- Cu\_ECRM
- Nb\_ECRM
- ▲ Mn\_ECRM
- Gr\_ECRM
- Fl\_ECRM
- Ni\_ECRM



Development Corridor Dataset

SCALE 1:9482674

--- Planned Major Roads and Rails

● Planned Airports and Ports

Figure 71 Location of Cluster 11: Eastern Africa (North)

7.11.2 Summary

In comparison to other clusters, Cluster 11 is not the richest country when it comes to ECRMs. Major occurrences are copper, graphite, niobium-tantalum, lithium, manganese, nickel, and fluorite in Kenya, South Ethiopia, and Uganda. However, the EU and Kenya signed an Economic Partnership Agreement (EPA) in 2023 to boost trade in goods. Furthermore, two major development corridors, namely the Lamu-South Sudan-Ethiopia Transport Corridor (LAPSSET) and the Standard Gauge Railway (SGR) project, provide (1) improved access to highly frequented and remote areas, which in particular connects the ECRM occurrences in East Uganda and South Ethiopia, (2) efficient public transport, (3) rapid growth of urban centres, (4) economic growth and development, and (5) increased trading opportunities. The EU already invested millions of Euros in infrastructure projects such as the Mombasa-Kilifi highway (€ 275m). Furthermore, the government of Kenya and the African Development Bank (AfDB) are investing millions of US\$ in airport and port infrastructure in Nakuru, Mombasa, and Lamu. Furthermore, Kenya recently revives the plans for a US\$ 13bn railway line to Ethiopia that will begin in 2025. With the EU partnership in place, Kenya offers great business opportunities to further exploit the ECRM occurrences in the cluster e.g., along the East African Rift System, while taking the preservation of protected areas in central Kenya and southern Ethiopia into account. Road and shipping infrastructure as well as ports are adequately developed for exploiting ECRM occurrences. Investments can therefore be focused on exploring, exploiting, and processing of ECRM occurrences. Moreover, investments in vertical and horizontal railway infrastructure linkages, airports, energy distribution and communication in the Lamu Port-South Sudan-Ethiopia Transport Corridor (LAPSSET) region and east Uganda’s hinterland would facilitate these processes. Cross-border development projects could interact with projects in cluster 10.

7.11.3 Assessment

**Main investment needs:** Mining, processing, rail, airports, energy, communication.

|                              |                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism is perceived to be low in Kenya and Uganda and high in Ethiopia. With respect to the African continent, Kenya is ranked 37 <sup>th</sup> , Uganda 34 <sup>th</sup> and Ethiopia 49 <sup>th</sup> of the 53-country dataset as of 2022. |
| Artisanal Small-Scale Mining | Ethiopia and Uganda are relevant ASM producer countries for ECRM in Africa. ECRMs exploited via ASM practices include mainly niobium-tantalum, tungsten, tin and PGEs beside the non-ECRM gold.                                                                                                                                                                               |

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|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mining                         | The main CRM mining products are manganese, fluorspar, titanium and niobium-tantalum. Further deposits cover nickel, fluorite, REE, gallium, lithium, phosphate, and copper. The documented mines and deposits are situated along the Lamu Port-South Sudan-Ethiopia Transport Corridor (LAPSSET) and the east to west Standard Gauge Railway (SGR) project that offers great potential to further explore and exploit ECRMs occurrences. Beside the two major corridors, several highway and railway projects exist that connect Kampala (Uganda) with the ports of Mombasa (Kenya) and Lamu (Kenya), which can be utilised for the transportation of materials.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Processing facilities          | Existing processing facilities focus on gold, lead, iron and steel, cement (dominant), diatomite, lime, aluminium (CRM), salt, and sulphur. The facilities are located adjacent to the Standard Gauge Railway (SGR) corridor, offering excellent conditions to develop inter-country or inter-cluster supply chains. Depending on the ECRM, further processing facilities can be built in the same regions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Road / shipping infrastructure | Road infrastructure is generally well established in southern Kenya and throughout Uganda, particularly along the Standard Gauge Railway (SGR) corridor. Development works include the construction or modernisation of highways between Kampala and Mombasa, from Isiolo (Kenya) to Lamu (Kenya) and Juba (South Sudan), as well as the general improvement of transportation roads. Primary and secondary roads in the channel from Uganda to the port of Mombasa are adequate for further exploration and exploitation activities. However, Uganda and Kenya have a high road traffic density that could lead to delays in road transportation. Investments can be made in partially modernizing highways between Kampala and Mombasa. The Isiolo and Addis Ababa (Ethiopia) highway within Lamu Port-South Sudan-Ethiopia Transport Corridor (LAPSSET) as part of the Cairo-Gaborone-Cape Town Road (Egypt to South Africa) connects central Kenya with the south of Ethiopia. Primary and secondary roads exist for access to remote areas. Investments can be made to improve transportation in Lake Victoria. This will enlarge the economic impact zone of the Standard Gauge Railway (SGR) corridor by strengthening inter-regional transport connections. This would provide opportunities to create a sea link between Kampala and the west of Kenya (Kisumu) to shorten the route to the Port of Mombasa and to relieve road traffic. As road infrastructure is adequately developed, seasonal inland navigation between Lake Victoria and Mombasa are negligible at first. |

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| Rail infrastructure | <p>The maturity level of rail infrastructure is similar to road infrastructure in the cluster. The Standard Gauge Railway (SGR) project, as well as other railway projects between Kampala, Nairobi (Kenya), Mombasa, and Lamu, focus on standard gauge and meter gauge railway and are all led by Kenya Railways. The port of Mombasa is well connected to Nairobi and Kampala. To connect the port of Lamu with Nairobi, Kampala, Juba, or the south of Ethiopia following the Lamu Port-South Sudan-Ethiopia Transport Corridor (LAPSSET) corridor, investments can be made in vertical and horizontal railway infrastructure linkages. The 472 km Nairobi-Mombasa rail segment for US\$ 3.8bn, of which 90 % was financed by China, can be used as rough cost estimation. Furthermore, Kenya recently revives the plans for a US\$ 13bn railway line to link Addis Ababa and Juba that will begin in 2025.</p> |
| Airports            | <p>Kenya has several national and international airports, mostly managed by Kenya Airport Authority. The international airports Kisumu, Jomo Kenyatta, Moi, Isiolo, Malindi, and Eldoret in Kenya, and Entebbe in Uganda, are directly connected to both the Standard Gauge Railway (SGR) and Lamu Port-South Sudan-Ethiopia Transport Corridor (LAPSSET) corridors. These can be used for air freight e.g., products, equipment, and personnel. Several national airports can be used for further individual distribution. To further explore the northern region of Lamu Port-South Sudan-Ethiopia Transport Corridor (LAPSSET), investments can be made in strategic airports to supply these areas with material and personnel resources.</p>                                                                                                                                                                  |



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| Ports  | <p>The following ports are led by the Kenya Ports Authority:</p> <p>The port of Mombasa is the main port of Kenya and serves as the main gateway to landlocked East-African countries such as Uganda, Rwanda, Burundi, DRC, and South Sudan. In 2016, the port underwent a US\$ 650m modernisation program and now boasts 20 deep water berths, nine conventional cargo operations, and eleven container handling terminals. Main donors were the Government of Kenya, the European Investment Bank, and the French Development Agency. The fully mechanised and digitalised port is capable of handling a total container capacity of 2.2 million TEUs annually with gantry cranes, 24 hour per day all year around. Beside the port of Mombasa, the port of Lamu will be the second commercial port of Kenya. The Lamu port project at Manda Bay is part of the Lamu Port-South Sudan-Ethiopia Transport Corridor (LAPSSET) corridor. Manda bay in Lamu was selected due to its natural depth of 18 m along the main channel to 60 m at the bay. The first three berths of the envisaged 23 berths port are already complete with containerised cargo operations at berth one already underway. Each berth has a quay length measuring 400 m with a depth of minus 17.5 m and is capable of comfortably docking panamax and post panamax vessels with a capacity of over 10,000 TEUs.</p> <p>The inland transit port of Kisumu at Lake Victoria focusses on transit cargo from Mombasa to the EAC region. The port occupies 17.5 hectares of land with an annual cargo handling capacity of 25,000 TEUs. The port has recently undergone massive rehabilitation works including dredging of the channel to accommodate larger vessels, upgrade of physical infrastructure and the improvement of safety and reliability of the lake transport system. Currently, the port has a berth length of 300 m and is envisaged to get an additional 400 m of docking area upon completion of dredging.</p> <p>Inland Container Depots in Nairobi and Naivasha that are directly linked to the Port of Mombasa by both Standard Gauge Railway (SGR) and the old Meter Gauge Rail (MGR) bring port services closer to customers and increase cargo offtake from the port to the hinterlands.</p> |
| Energy | <p>Most power stations produce renewable energy (predominantly solar, hydro, wind, biomass) with generation capacities ranging between 100-1000 MW, most of which are located along the SGR development corridor. The hinterland of Uganda and Lamu Port-South Sudan-Ethiopia Transport Corridor (LAPSSET) are partially supplied with power station having a capacity between 10-100 MW. Therefore, the exploration and potential exploitation of ECRMs in these regions would lead to a lack of sufficient power supply. Investment can then be made in power station that are linked to (extreme) high voltage power transmission lines with up to 500 kV.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

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| Communication | <p>The submarine fibre cable systems DARE, Africa-1, Liquid Sea, TEAMS, EASSy, and LION2 having their landing points in Mombasa. EASSy has a design capacity of more than 10 Tbit/s being the second highest capacity system after WACS. Most prominent terrestrial fibre optic cable system in Kenya is SEACOM, serving the SGR area. The most prominent telecommunication providers are Airtel Kenya Ltd. and Safaricom ensuring mobile data up to 5G in the SGR area and LAPSET. Airtel Mobile in Uganda only provides sufficient mobile data in the Kampala region, whereas the mobile data network in the south of Ethiopia by MTN or Safaricom is limited. Investment needs to be made if ECRMs are explored to ensure sufficient communication standards in the Ugandan hinterland or the south of Ethiopia.</p> |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Table 94 Infrastructure assessment of Cluster 11: Eastern Africa (North)**

## 7.12 Cluster 12: Democratic Republic of the Congo

|                                                      |                                      |
|------------------------------------------------------|--------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 27,780769, Y -6,939759             |
| Area estimated                                       | 210,000 km <sup>2</sup>              |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Niobium-Tantalum, Tin        |
| Country coverage                                     | Democratic Republic of Congo, Zambia |

### 7.12.1 Location

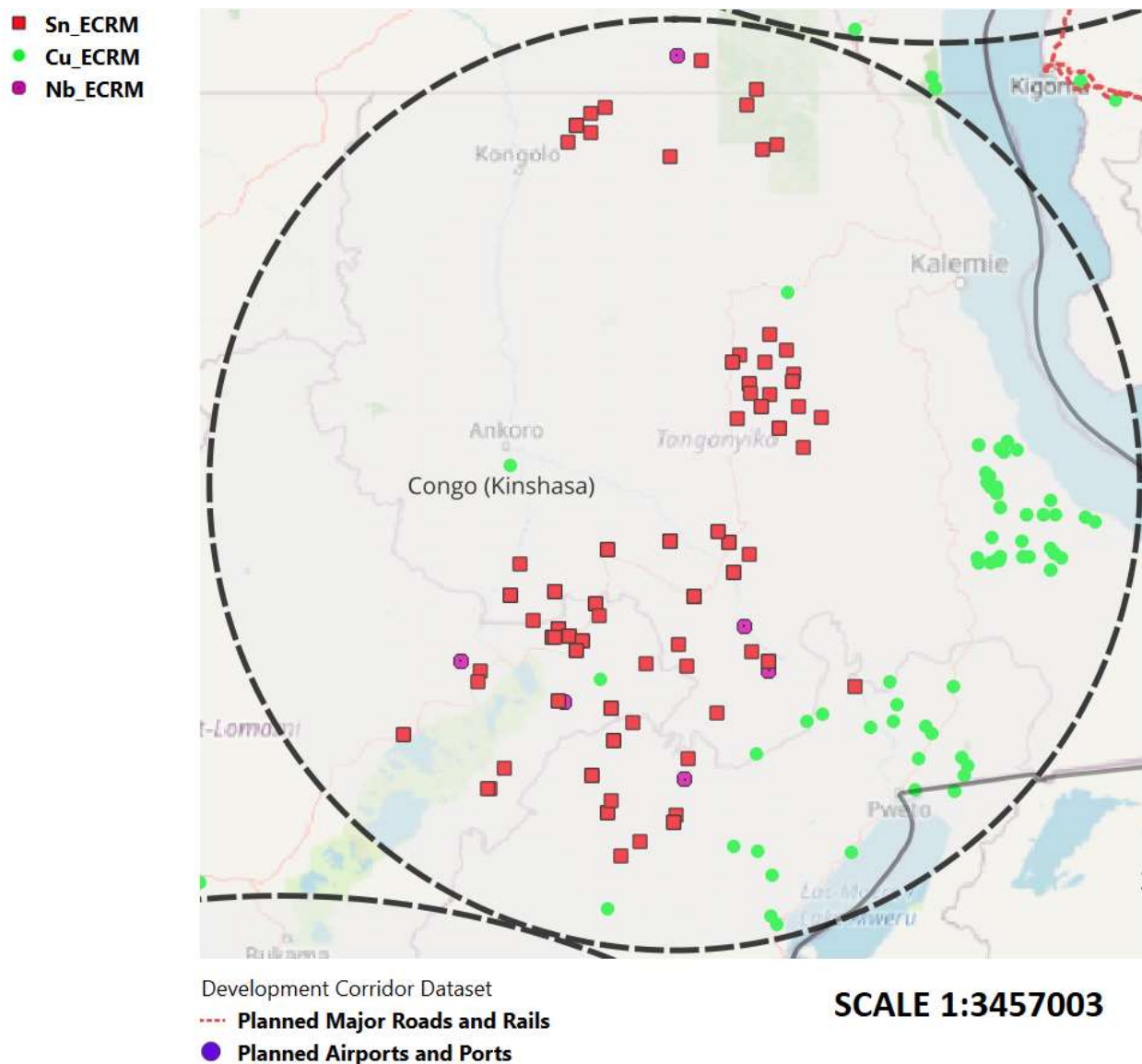


Figure 72 Location of Cluster 12: Democratic Republic of the Congo

### 7.12.2 Summary

The cluster is found in the DRC and contains considerable copper, tin, and niobium-tantalum occurrences. DRC is considered moderately politically stable, having recently experienced a spike of violence due to territorial disputes in the mineral-rich eastern regions. DRC is famously known as one of the world's largest producer of copper, cobalt, and diamonds. DRC has a rich history in the ASM sector, exploiting a variety of different commodities, mainly tin, tantalum, tungsten, gold (3TG), cobalt and diamonds. Due to a lack of processing facilities in the cluster, business opportunities may arise for their development, especially in corridor spaces. Most of the roads in DRC are dilapidated or non-existent and have not been maintained in decades. Important roadways include the N5 and the N33 national roads, providing key links to external development corridors. Road infrastructure development will require funding and diligent compliance measures to create and enable efficient transport networks within the cluster. The Société Nationale des Chemins de Fer du Congo (SNCC) network connects the DRC's southern region and is used extensively for copper exports leaving the DRC for the Port of Durban and will also facilitate exports through Lobito in Angola once construction on the Benguela Railways is completed. The Société Nationale des Chemins de Fer du Congo (SNCC) network is in poor condition, with speed limits of 10-35 km/h. However, there is significant business potential to rehabilitate railway lines in the cluster to relieve road freight logistics and establish efficient project to port networks. The inland cluster relies on distant international seaports as far away as Dar es Salaam and Tanga in Tanzania, Mombasa in Kenya, Lobito in Angola, Baira and Nacala in Mozambique, and Durban in South Africa, to reach international markets outside of Africa. Energy infrastructure is extremely scarce in the cluster. Business opportunities exist to harness the region's immense renewable potential, as well as to develop the grid network throughout the cluster. Telecommunications in DRC are poor and opportunities for improvement exist. Low internet penetration rates leave potential for the development of higher-speed networks linking the DRC to submarine cables linked to Europe and Asia. Hampered by poor physical infrastructure, particularly last mile infrastructure, mobile telephone services have grown to fill the role of land line telecommunications. Most of the population is not connected to the internet and only 1 % has access. Cross-border development projects could interact with projects in cluster 10, 11, 15 and 16.

### 7.12.3 Assessment

**Main investment needs:** Mining, processing, road, rail, airports, energy, communication.

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|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as moderate in the Democratic Republic of the Congo (DRC). With respect to the African continent, the DRC is ranked 47 <sup>th</sup> of the 53-country dataset as of 2022. According to the Council on Foreign Relations (2023), DRC experienced a spike of violence late in 2023 leading up to the country's general elections. This was especially prevalent in the resource-rich eastern provinces of the country. |
| Artisanal Small-Scale Mining | The DRC is Africa's most important ASM ECRM producer, and Zambia has an important ASM sector as well. Artisanal ECRM exploitation in DRC covers cobalt, copper, rare earth elements, tantalum-niobium, tin, tungsten, in few areas PGE as well as additional non-ECRMs mainly gold, diamonds. Zambian ASM includes manganese and copper. ASM has been a part of the mining history in DRC and remains an important sector today. The sector is attracting international support in the form of funding, legislative actions, and due diligence programs.                   |
| Mining                       | DRC is the world's largest producer of copper and cobalt, as well as the second largest diamond producer. It also comprises of rich gold, zinc, and potash deposits. Available data identifies nine mining projects within the cluster, consisting of copper (2), gold (1), silver (2), tantalum (2), and tin (2) operations. The cluster's mining landscape thus remains largely underdeveloped, with great potential to exploit the vast ECRMs. Investments can be made to support ECRM exploration projects turning operational.                                        |
| Processing facilities        | According to available data, the cluster contains a single cement processing facility in the region's northeast. Considering the ECRM distribution, the cluster is strategically positioned to capitalise on the three commodities most present. Investments will be required to construct ECRM processing facilities to support the expansion of respective mining activities.                                                                                                                                                                                            |

## Road / shipping infrastructure

DRC's road network is in an extreme state of disrepair following years of poor maintenance and damage due to armed conflicts. The cluster is characterised by exhibiting both qualitatively and quantitatively insufficient roadway. Road infrastructure consists solely of secondary (national and regional) roads. Nevertheless, the limited roadways manage to provide relatively good coverage of the documented ECRM occurrences. The two national roads intersecting the cluster (N5 and N33) navigate past many of the demarcated ECRMs and provide links with DRC's capital of Lubumbashi to the south. They furthermore enable access to nearby development corridors via Lake Tanganyika to the east and the Burundian border to the north. The cluster contains no development corridors. Nearby corridors include (1) the Beira-Lobito Corridor to the south, (2) the North-South Corridor to the north, and (3) Tanzania's Central Development Corridor (Tanzania Standard Gauge Railway) to the east. Business opportunities exist to upgrade and modernise the cluster's two critical (national) roadways to create efficient transport routes (i.e., links to development corridors) for the landlocked cluster. Further investments may be necessary to construct access roads to potential ECRM projects/hotspots.

Kigoma (Tanzania) is the busiest port on Lake Tanganyika, which is linked by ferry to DRC's lake Port of Kalemie (along the N5 road in the cluster). This link provides direct access to the Central Development Rail Corridor in Tanzania and is the cluster's most direct route to a seaport (Dar es Salaam, Tanzania). The Port of Kalemie is identified as a critical node in the lake transport system. To fully untap the port's potential, investments will be required to improve and modernise the port's infrastructure facilities to accommodate ECRM activities in the cluster.



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| Rail infrastructure | <p>According to a report by Africa Infrastructure Country Diagnostic (AICD), the DRC has two main rail systems of strategic importance to the country: Chemin de Fer Matadi-Kinshasa (CFMK)/Société Commerciale des Transports et des Ports (SCPT) and Société Nationale des Chemins de Fer du Congo (SNCC). Société Nationale des Chemins de Fer du Congo (SNCC) operates an extensive network centred in the southeast of the country and manages the railway segment found in the cluster. Section 2 of the Great Lakes railway line, operating between Kalemie and Kabalo, joins with the Katanga line, providing a link to Lubumbashi and the all-important Lobito Corridor (via Tenke). The rail section found in the cluster is highly degraded and requires rehabilitation and modernisation. Funding from the World Bank for the rehabilitation and upgrade of 1,200 km and 487 km, respectively, of Société Nationale des Chemins de Fer du Congo (SNCC) rail track was launched in 2010. Works on the segment between Lubumbashi and Kabalo were included, however, works on the Kabalo-Kalemie segment remain open. The World Bank has launched an eight-year plan for improving the DRC Multi Modal Transport in the south and south-east of the country, which is the area of operation of the Société Nationale des Chemins de Fer du Congo (SNCC). In coordination with the implementing agencies, the Ministries of Finance and Transport, the project aims to commit US\$ 631m for renewing tracks, trains, and boats to improve the competitiveness of the Société Nationale des Chemins de Fer du Congo (SNCC) for exporting goods and minerals. Business opportunities exist to support railway improvement efforts in the cluster. Establishing a rail connection with the Lobito Corridor will furthermore create additional trade opportunities for the region.</p> |
| Airports            | <p>The cluster contains no international airports. Lubumbashi and Goma International Airports are accessible to the south and north of the cluster, respectively. Both airports are accessible to the cluster via the N5 national road. DRC's air transport sector is not reliable with a dilapidated airport infrastructure system, which requires public and private investment for rehabilitation. Smaller, regional airports are, however, found throughout the cluster and can be used to transport cargo and personnel to service potential ECRM projects. Business opportunities exist to construct additional remote airfields to support isolated occurrences.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Ports               | <p>The inland cluster contains no seaports. As such, the cluster relies on ports such as Dar es Salaam and Tanga in Tanzania, Mombasa in Kenya, Lobito in Angola, Baira and Nacala in Mozambique, and Durban in South Africa, to reach international markets outside of Africa. Regional development corridors provide crucial links to the abovementioned ports.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

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|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Energy        | <p>The DRC's immense energy potential consists of non-renewable resources such as oil, natural gas, and uranium, and renewable energy sources including hydroelectric, biomass, solar, wind, and geothermal power. The National Society of Electricity (SNEL) is a state-owned company responsible for producing, transmitting, and distributing electricity in the DRC. It has a generation capacity of approximately 2,416 MW (96 % hydroelectric power), sourced primarily by the Inga I and Inga II dams located in the Kongo Central province. Current production is only 6,000 to 7,000 GWh. Nevertheless, given the nation's vast energy resources, the cluster's energy infrastructure landscape is heavily underdeveloped. It consists of three power plants with generation capacities between 10-100 MW, and two smaller plants with generation capacities &lt;10 MW, all of which are renewably sourced. Bendera-Kyimbi Hydro and Piana Mwanga Hydro are both operated by SNEL with capacities of 41.2 MW and 54 MW, respectively, and are the only on-grid plants. Manono Solar Power Plant is the largest 100 % off-grid solar plant in Africa. Power distribution infrastructure is similarly extremely scarce. The region, however, has great potential to link to the nation's extra high voltage backbone (largely powered by the Inga II Hydro station). Business opportunities exist to harness the region's immense renewable potential, as well as to develop the grid network throughout the cluster. Currently, most ECRM occurrences remain inaccessible to power.</p> |
| Communication | <p>The telecommunications industry has not yet reached all potential consumers and has room to grow. Mobile telephones have a 44 % penetration rate, while internet penetration is approximately 3 % of the total population. The DRC has not yet reached 5G and is still developing its 3G/4G network. The low penetration rate leaves great potential for the development of higher-speed networks and linking the DRC to submarine cables at the coast. The nation's terrestrial fibre optic network remains largely in an infancy stage. Fibre infrastructure in the cluster is only found along the N5 national road. Investments will be necessary to support the development of the cluster region and the success of potential ECRM projects. Hampered by poor physical infrastructure, particularly last mile infrastructure, mobile services have grown to fill the role traditionally filled by land line telecommunications. Less than 1 % of internet connections in the country are land line connections, making the country's mobile telephone operators de facto internet service providers for private and commercial uses. Significant mobile network providers are Africell, Airtel, Orange Mobile, and Vodacom, providing up to 4G+ in limited areas of the cluster (Kalemie). Network coverage nevertheless remains mostly underdeveloped in the cluster. Investments will be required to improve mobile network coverage, as well as to support the expansion of DRC's terrestrial fibre optic network.</p>                                                              |

**Table 95 Infrastructure assessment of Cluster 12: Democratic Republic of the Congo**

### 7.13 Cluster 13: Angola

|                                                      |                                               |
|------------------------------------------------------|-----------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 15,031715, Y -14,456728                     |
| Area estimated                                       | 430,000 km <sup>2</sup>                       |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Manganese, Nickel, Titanium, Fluorite |
| Country coverage                                     | Angola, Namibia                               |

#### 7.13.1 Location

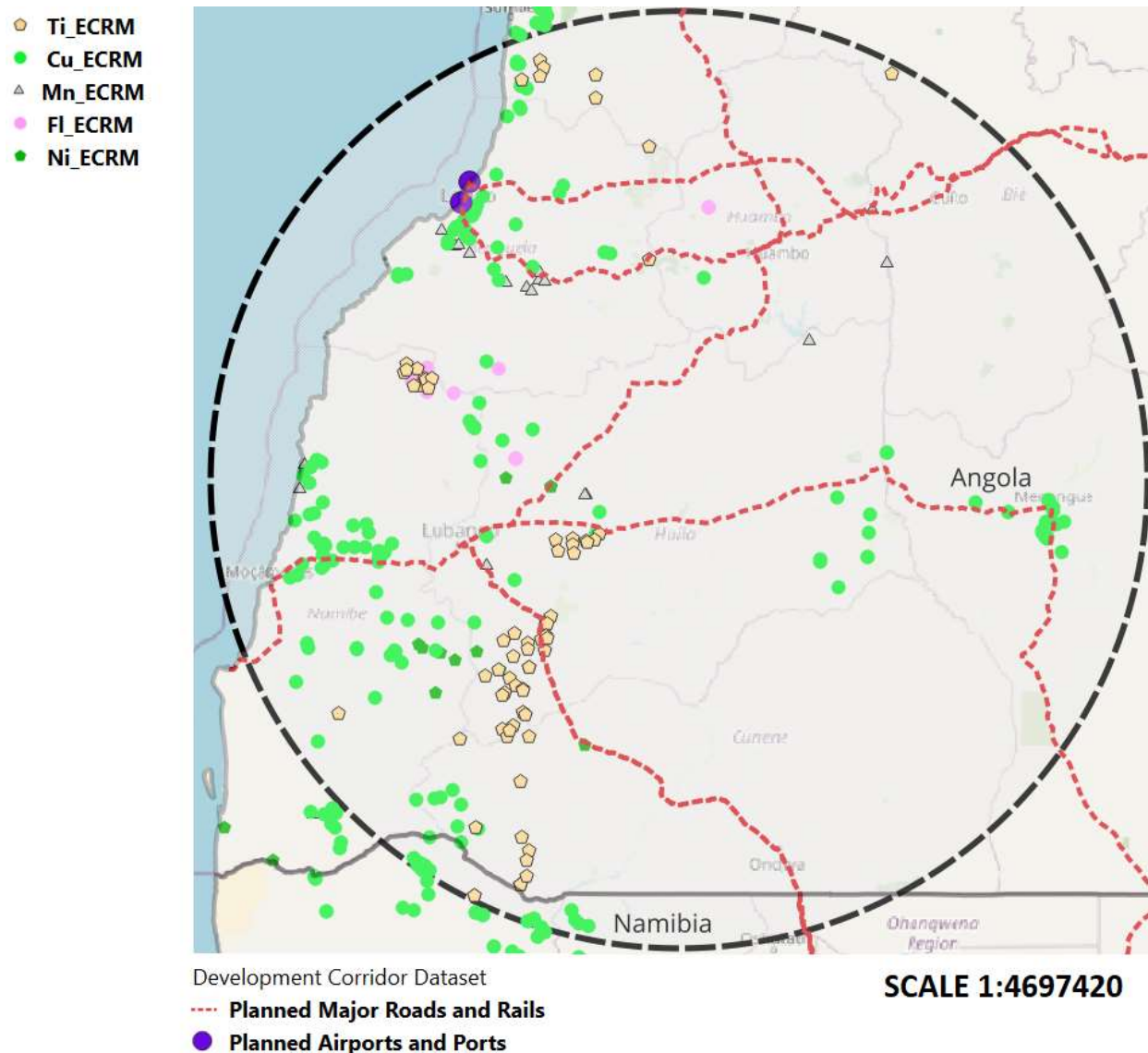


Figure 73 Location of Cluster 13: Angola

7.13.2 Summary

Cluster 13 is comprised of mineral commodities of ECRMs copper, manganese, nickel, titanium, and fluorine. It primarily constitutes the Angolan landmass, although it slightly overlaps with Namibia, of which both countries are considered politically stable. In general, ASM and small-scale mining (SSM) in Namibia exist with different dimensions and have been present for many years. Recent developments have seen governments developing legislations in a bid to formalise the sector and recognise it as economically important. There are no active mines in the cluster. However, the cluster boasts substantial ECRM occurrences currently in exploration phases, which may be further developed into operating facilities. Both countries lack processing facilities and the develop thereof must be go hand-in-hand with the expansion of ECRM mining projects. The cluster is intersected by five development corridor projects. The Tripoli-Windhoek-Cape Town Highway is part of the Trans-Africa Highway (TAH-3) initiative and serves as the second link between northern and southern Africa. The Benguela and Namibe development highway projects serve as arteries to the two ports in the cluster. Angola has three railway systems run by public companies, two of which are found within the cluster. Business opportunities in cross-border railway infrastructure between Angola and Namibia should be investigated. Angola is a development hub for fibre optic networks that will connect with other countries in Europe and Asia. Angola plans to link the nation’s power grids through a north-central-south backbone and expand the grid from 3,354 km to 16,350 km by 2025. Namibia’s domestic electricity generation plants, however, supply less than one-third of power consumption. As a result, Namibia imports most of its electricity primarily through bilateral contracts with South Africa’s national power utility (Eskom) and to a lesser extent, the Southern Africa Power Pool. Cross-border development projects could interact with projects in cluster 14 and 15.

7.13.3 Assessment

**Main investment needs:** Mining, processing, road, rail, energy, communication.

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in Namibia and Angola. With respect to the African continent, Namibia is ranked 6 <sup>th</sup> and Angola 30 <sup>th</sup> of the 53-country dataset as of 2022.                                                                                                                  |
| Artisanal Small-Scale Mining | The term "small-scale mining" (SSM), as opposed to ASM, is used in Namibia, a minor SSM producer country for ECRMs in Africa. Small-scale mining (SSM) refers to mining with minimal machinery and/or simple technology with very low capital requirements. ECRMs exploited via small-scale mining (SSM) practices include copper, tin, tantalum, fluorspar, and lithium, as well as non-ECRMs like semi-precious stones and dimension stones. |

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|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mining                         | <p>Angola is known for mining alluvial diamonds since its inception in 1912 and the economy depends on this resource for its growth, accounting for 90 % of total mining revenues. However, other resources that are mined in the country include iron ore, manganese, copper, phosphates, granite, and others. Nevertheless, no mining projects exist within the cluster boundaries. A rise in private investment has seen exploration projects in Angola receive governmental approval. The cluster's coastal location fosters favourable conditions for the start-up of potential ECRM projects, since transportation costs can remain significantly low. The largely underdeveloped mining landscape will therefore require investments to support the abundant ECRM occurrences turning operational.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Processing facilities          | <p>According to available data, the cluster contains two cement processing facilities near Lobito. As such, and with respect to the ECRM mining potential in the region, investments will be required to construct the respective mineral processing facilities. Synergies between the location(s) of such facilities and the region's development corridors should be considered to facilitate efficient transport channels.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Road / shipping infrastructure | <p>Angola has invested heavily in the reconstruction of its dilapidated road infrastructure since the end of the civil war in 2002. Public accounts show that spending on roads and bridges amounted to an estimated US\$ 27.5bn over the period 2002-18, averaging US\$ 1.6bn yearly. This makes Angola one of the highest spenders on road infrastructure in Africa. Accordingly, Angola has an extensive road network covering a total distance of around 76,000 km, with its fundamental road network comprising about 26,000 km. However, the country's roads remain in a relatively poor condition. Nevertheless, the extensive road network provides many of the cluster's ECRM occurrences with access. Business opportunities therefore exist to both expand the road network and rehabilitate/modernise important thoroughfares in the region (e.g., titanium occurrences in the cluster's south). In terms of regional integration, the cluster is intercepted by multiple important development corridors. Angola's most salient international road corridor connects the country to the DRC and Zambia in the east (Lobito Corridor). These road corridors, however, also remain in a rather poor condition, making regional connectivity with the Southern African Development Community (SADC) economic area difficult. This situation both prevents Angola from developing regional trade with surrounding countries and limits these countries from making greater use of the ports of Luanda and Lobito. The government's Road Infrastructure Maintenance Program (PRIR) has resulted in more than 13,232 km of the country's fundamental road network being asphalted since 2011. According to Angola's Road Institute (INEA), road works to asphalt a further 7,620 km are reportedly in the contract signing stage or have already begun. The government also disclosed information on the current road conditions linking the country's main corridors to Southern African Development Community (SADC) countries; their total distance covers 6,216 km, of which 4,628 km (74 %) is already paved.</p> |

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|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rail infrastructure | <p>Angola has three railway systems run by public companies, comprising a total rail extension of nearly 2,700 km. These were built eastwards from the coast in colonial times, linking the country's key Atlantic ports (Luanda, Lobito, and Namibe) to the hinterland. Of these, the railways linking Lobito and Namibe are found within the cluster. Benguela Railways (Caminho de Ferro de Benguela – CFB: 1,344 km) connects Lobito to the eastern border-town of Luau and to the rail networks of south-western DRC. This line was rehabilitated in 2013 and is now fully operational. It is mostly used for the transport of minerals coming from the DRC and Zambia to be exported through the port of Lobito. This railway line forms part of the Lobito Corridor, a project heavily supported by the EU and the US due to its strategic importance. Both parties have invested largely in the rail project in a bid to access the ECRM rich areas of the DRC and Zambia via the Atlantic coast. Moçamedes Railways (Caminho de Ferro de Moçamedes – CFM: 856 km) connects Namibe to the eastern province of Kuando Kubango. This line was rehabilitated and has been operational since 2015. It is mostly used for the transport of iron coming from Cassinga and to be exported through the Port of Namibe. Moçamedes Railways have furthermore announced plans to develop a 300 km rail link connecting Angola with Namibia at the Oshikango/Santa Clara border. This forms part of the government's plan to enhance regional connectivity and boost trade. Current and ongoing rail developments should adequately serve the cluster.</p> |
| Airports            | <p>Angola International Airport is located in Luanda and is served by several international and domestic airlines. Flights from and to Portugal and Brazil are very common and reflect the cultural ties between these countries. The international terminal of the Luanda airport was refurbished in 2010. Airports that fall in this cluster are Catumbela, Namibe, Lubango, Ondjiva, Menongue, Huambe, and Kuito. The Angolan government has planned to construct new airports and refurbish the existing ones. The total planned investments in Angola's airport infrastructures are expected to reach nearly US\$ 175m. The majority (60 %) of these investments are anticipated to take place in the short term and, of these, the largest share (47 %) is expected to be allocated to the capacity expansion of the existing airports.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |



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|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ports  | <p>Angola has five seaports located along the Atlantic coast of the country and two of them overlap into the cluster, namely the port of Lobito and the port of Namibe. The port of Lobito supplies Angola's Planalto Central region along the Benguela railway. It is located in the middle of the Angolan coast, 500 km south of Luanda. It is a deep-water seaport with five different types of terminals: (1) general cargo, (2) container, (3) dry port, (4) support, and (5) mining. The container terminal has modern facilities, while the mining terminal has a railway connection to the Benguela Railway linking Lobito to the ECRM-rich regions of the DRC and Zambia. This provides the port of Lobito with huge potential to become the main port for the export of minerals from these two countries. It is the only seaport that has a railway connection to a bordering country, namely the DRC, thus offering potential to handle imports and exports of goods and raw materials from the southern region of the country. The port was refurbished in 2014 in anticipation of the completion of the Benguela Railway for the export of copper and other minerals to these two countries in a US\$ 1.2bn program. It is also well connected to the national road network. Currently, the port handles container cargo, bulk cargo, construction materials and imports of oil derivatives. It is also responsible for about 10 % of the total imported and exported cargo in the country. The port of Lobito now has capacity to handle 2.9 million t of cargo per year, including the export of refined oil products. The port of Namibe is currently the third largest seaport in the country and is mostly used for the transportation of mining products, including exports of granite and iron ore, as well as the transportation of fuel to Angola's southern provinces. It is well connected to the national road network and the Moçâmedes Railway. The port underwent a US\$ 3bn refurbishment program completed in 2015 and has the capacity to handle 1.4 million t of cargo per year. The modernisation works will also allow 30 to 35 movements per hour. Its standstill capacity was increased from 1,700 to 2,700 TEUs and its refrigeration connections from 25 to 100 power plugs. These works also included the rehabilitation of 240 m of the pier and paving the existing container park. The two ports should adequately serve the region.</p> |
| Energy | <p>Angola's current installed capacity is estimated at 5.7 GW but only 70 % is in use. The country's current energy mix consists of 61.8 % from hydropower, 37.6 % from fossil fuels, and 0.6 % via hybrid installations (solar/fossil fuel). Angola's transmission infrastructure is made up of three separate major grid systems (northern, central, and southern), in addition to isolated grids in the east. The northern grid runs 400 kV and 220 kV lines, and covers Luanda, Uige, Bengo, Zaire, Malange, Kwanza Norte, and Kwanza Sul provinces. The central network includes 220 kV lines from Benguela to Huambo and Bie. The southern grid serves Huila and Namibe and uses 220 kV lines. Cluster 13 comprises of the central and southern grid systems. Plans exist to link the grids through a north-central-south backbone and expand the grid from 3,354 km to 16,350 km by 2025. Nevertheless, business opportunities exist to expand the power generation and transmission infrastructure in the cluster to support the take-off and expansion of potential ECRM projects.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Communication | <p>Angola has invested strategically into becoming an alternative hub for the southern and central region of Africa, building datacentres, satellite stations, and installing fibre optic networks to connect the country internally, to the continent, and to the world. The government liberalised the telecommunication market that contributed to enabling access to phones and the internet. Angola uses fibre infrastructure of 29 satellite earth stations, as well as hosting a landing station for the SAT-3/WASC, 2 Africa, South Atlantic Cable System (SACS), and the West Africa Cable System (WACS) submarine fibre optic cables, providing connectivity to Europe and Asia. There is major connectivity discrepancy between urban and rural areas. Although Luanda is Angola’s largest and best-connected city, infrastructure, market, and affordability challenges cripple connectivity throughout the country. The objective is to tackle this discrepancy by establishing more infrastructure and players in the market. Telecom is Namibia’s largest telecommunication company and has a network of 296 mobile base stations; several sites are equipped with 3G and 4G technology for mobile broadband. Namibia has cellular coverage in most towns and road coverage along many of the major routes in the country. Nevertheless, many remote areas within the cluster lack network coverage and will require supporting investments.</p> |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

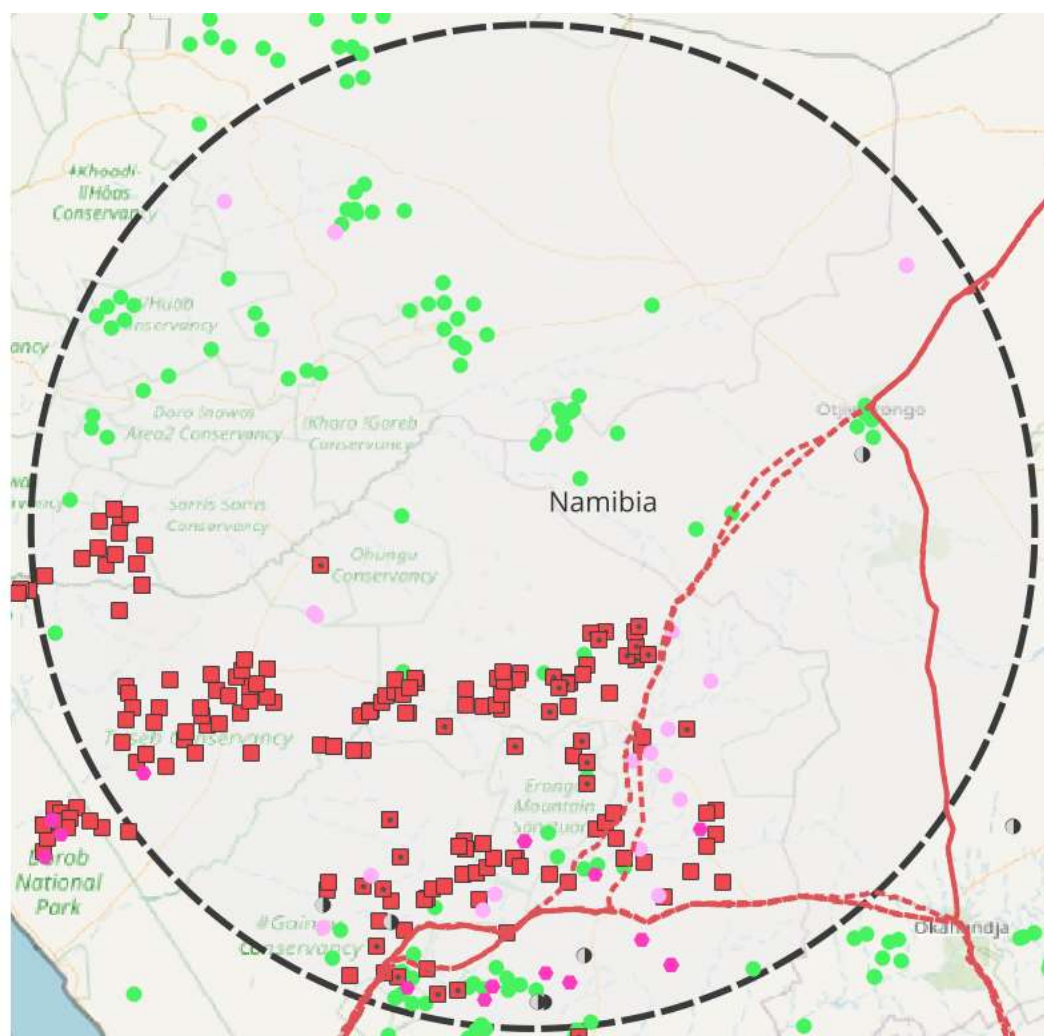
Table 96 Infrastructure assessment of Cluster 13: Angola

## 7.14 Cluster 14: Namibia

|                                                      |                                                    |
|------------------------------------------------------|----------------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 15,658173, Y -20,812112                          |
| Area estimated                                       | 84,000 km <sup>2</sup>                             |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Graphite, Lithium, Tin, Tungsten, Fluorite |
| Country coverage                                     | Namibia                                            |

### 7.14.1 Location

- Li\_ECRM
- FI\_ECRM
- Gr\_ECRM
- W\_ECRM
- Sn\_ECRM
- Cu\_ECRM



Development Corridor Dataset

--- Planned Major Roads and Rails

● Planned Airports and Ports

SCALE 1:1952459

Figure 74 Location of Cluster 14: Namibia

### 7.14.2 Summary

Namibia has been a politically stable country with strong governance and institutions. It is rich in ECRM mineral resources including copper, graphite, lithium, tin, tungsten, and fluorite. The mining sector in the Erongo Region (Cluster 14 concentration) consists of both small-scale mining (SSM) and industrial mining practices and has been characterised by the establishment and expansion of several uranium mines over the past decade due to an increased demand for this energy source. The Erongo Region also accommodates the mining of commodities such as gold, marble, granite, salt, and semi-precious stones. Mining and quarrying contribute about 12 % to national GDP, 51 % to foreign exchange earnings, of which diamonds and uranium are the most important. The cluster contains no processing facilities to accommodate the build out and expansion of ECRM mining activities. Investments will be necessary for the construction of new processing plants and/or smelters to be built. The location of such plants should take the Walvis Bay development corridors into consideration to optimise transport channels. Road infrastructure in the region is well developed, providing adequate coverage and access to many of the mapped ECRM occurrences. Investments in upgrading roadways of strategic importance, as well as in maintaining the multiple development corridors will be beneficial to the region's success. Rail infrastructure in the cluster is well developed and maintained. Business opportunities exist to expand the network within the cluster to capture ECRM-rich zones, however, will be subject to financial feasibility with respect to the supporting road infrastructure and the relative proximity to the coast (and the Port of Walvis Bay). The Port of Walvis Bay on the central coast is the country's main harbour and a hub for corridors to Botswana, South Africa, Zimbabwe, southern Angola, Zambia, and the southern Democratic Republic of Congo. Walvis Bay will serve as the perfect trade gateway facility for exporting the cluster's mineral resources. It connects with the Trans-Caprivi, Trans-Kalahari, and Walvis Bay-Ndola-Lubumbashi Development Corridors. Power generation in the cluster is limited, although well supported by far-reaching transmission infrastructure, and moderately captures the regions ECRM potential. As such, investments in both generation and transmission infrastructure may be required. Telecommunications throughout the cluster provide good coverage at limited capacity. Current investments in base stations and the continued expansion of the terrestrial fibre optic network should adequately serve the cluster. Key synergies are identified with the completed and ongoing works of the African Development Bank (AfDB), the World Bank, the OPEC Fund for International Development, the EU, the Namibian Airport Company, the Namibian Ports Authority, Telecom and Paratus Namibia, and the Government of Namibia. Cross-border development projects could interact with projects in cluster 13, 15 and 19.

### 7.14.3 Assessment

**Main investment needs:** Mining, processing, road, rail, energy.

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in Namibia. With respect to the African continent, Namibia is ranked 6 <sup>th</sup> of the 53-country dataset as of 2022. The state welcomes foreign investment to explore mineral resources, creating great opportunities to invest in ECRM projects.                                                                                                                                                                                                                                                                                                                           |
| Artisanal Small-Scale Mining | The term "small-scale mining" (SSM), as opposed to ASM, is used in Namibia, a minor small-scale mining (SSM) producer country for ECRMs in Africa. Small-scale mining (SSM) refers to mining with minimal machinery and/or simple technology with very low capital requirements. ECRMs exploited via small-scale mining (SSM) practices include copper, tin, tantalum, fluorspar, and lithium, as well as non-ECRMs like semi-precious stones and dimension stones.                                                                                                                                                                                                                                                                           |
| Mining                       | Mining contributes around 12 % to the country's economy and more than 50 % to its export revenues. It is home to minerals including diamonds, magnesium, zinc, silver, gold, lead, copper, lithium, nickel, cobalt, uranium, and REEs. According to Global Data, there are 135 mines in Namibia, 27 of which are operational, however most of them (77) currently at the exploration stage, signalling high interest from mining companies.                                                                                                                                                                                                                                                                                                   |
| Processing facilities        | The cluster contains one cement processing plant, however facilities for gold, copper, pyrite, and salt are found nearby. The Namibian Custom Smelter (NCS) in Tsumeb is one of the few smelters in the world to treat concentrated copper, and may be utilised by the cluster. Although it lies outside of Cluster 14, it is accessible via the Trans-Caprivi Corridor (Walvis Bay-Ndola-Lumbumbashi Development Corridor) and the Tripoli-Windhoek-Cape Town Highway to the northeast. Investments in additional processing facilities to support the take-off of the numerous ECRM occurrences in the region will be necessary. Synergies with the cluster's development corridors should be considered to harness the region's potential. |

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|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Road / shipping infrastructure | <p>8,300 km of Namibia's 49,000 km road network is tarred, over 25,000 km is standard gravel, and the remainder is earth gravel and sand tracks. The Road Fund Administration (RFA) will contribute NA\$ 1.5bn (US\$ 785m) for road maintenance projects, including the upgrading of the Eneas Peter Nanyemba Road in Windhoek (formerly known as the Monte Christo Road) to a dual carriageway, the re-gravelling of roads in Etosha National Park, and the construction of several low-volume sealed roads countrywide.</p> <p>Namibia has a well-established road infrastructure, providing links to Angola, Zambia, Zimbabwe, Botswana and South Africa. The cluster area consists of few primary (trunk) roadways, however, is well supplemented by the secondary (national and regional) road network. As such, many of the documented ECRM occurrences are accessible or near the existing road network. Business opportunities therefore exist to (1) upgrade the quality of regional thoroughfares in ECRM rich areas, and to (2) construct access roads to currently inaccessible areas.</p> <p>The cluster contains multiple development corridors. The Trans-Kalahari and the Trans-Capriivi highways provide a fast and comfortable road link between the Port of Walvis Bay on the Atlantic coast and landlocked neighbouring countries. In particular, the Trans-Kalahari Highway links the Port of Walvis Bay to Botswana and the Gauteng province of South Africa, while the Trans-Capriivi Highway links the port to the landlocked neighbouring countries of Zambia, Zimbabwe, and the Democratic Republic of Congo.</p> |
| Rail infrastructure            | <p>The Namibian rail network consists of 2,687 km of tracks linked to South Africa and southern Angola. The government continues to invest heavily in the upgrading of the country's rail network to comply with the minimum Southern African Development Community (SADC) standards of 18.5 t per axle load with design speeds of up to 100 km/h for passenger trains and 80 km/h for freight trains. Following the completion of the 107.5 km railway line upgrade between Walvis Bay and Kranzberg, the government is engaging with the African Development Bank (AfDB) to secure funding for the upgrading of the Kranzberg-Tsumeb-Grootfontein section of the railway line which forms part of the Trans-Cunene Corridor. The upgrade will be executed in two phases: (1) Kranzberg to Otjiwarongo, as well as Otjiwarongo to Tsumeb and Otavi to Grootfontein.</p> <p>The final feasibility study for the extension of the railway network from Grootfontein to Katima Mulilo has found that the project is viable from a technical, environmental, legal, and financial perspective. The 772 km-long Trans-Zambezi railway line will facilitate the transportation of minerals from the Zambian Copperbelt to the port of Walvis Bay by linking new mines and mining activities to the railway network along the Walvis Bay-Ndola-Lubumbashi Development Corridor. The project will cost an estimated US\$ 2.3bn (NA\$ 46bn).</p> <p>Business opportunities may exist in extending the rail network within the cluster to capture areas of large ECRM potential (e.g., tin occurrences in Erongo region).</p>                        |



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| Airports | <p>The cluster contains several regional, small-scale airports. Namibia's two international airports, namely Hosea Kutako International Airport and Walvis Bay International Airport, are proximal to the cluster and accessible via the development corridors. The Namibian Airport Company (NAC) plans to upgrade facilities at Hosea Kutako International Airport, including commercial facilities, an apron expansion, and the addition of Terminal 3. Given the cluster's well-established road and rail networks, further investments in airport infrastructure may not be necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Ports    | <p>Namibia contains two ports: (1) the Port of Walvis Bay on the central coast and (2) the port of Lüderitz in southern Namibia. Both ports are owned and managed by the Namibian Ports Authority (Namport). The Port of Walvis Bay on the central coast is the country's main harbour and a hub for corridors to Botswana, South Africa, Zimbabwe, southern Angola, Zambia, and the southern Democratic Republic of Congo, and directly serves the cluster. The Namibian Ports Authority have announced a large-scale expansion project at the Port of Walvis Bay to the scale of US\$ 2.1bn, of which the EU has committed over US\$ 1bn. Current port infrastructure and planned investments should adequately serve the cluster.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Energy   | <p>Namibia's main energy sources are petroleum, hydropower, imported electricity and imported coal. Currently, less than 50 % of the population has access to power. The country's traditional generation capacity consists of a mix of hydropower, coal, diesel and thermal. The four state-owned power stations currently supplying electricity to the domestic market are: Anixas (diesel, 22 MW), Paratus (diesel, 16 MW), Van Eck (coal, 120 MW) and Ruacana (hydro, 330 MW). All four plants are owned and operated by the national power utility, NamPower, which also owns and operates the national transmission system. These domestic electricity generation plants, however, supply less than one-third of power consumption. As a result, Namibia imports most of its electricity primarily through bilateral contracts with South Africa's national power utility (Eskom) and to a lesser extent, the Southern Africa Power Pool.</p> <p>The cluster lacks in power generation infrastructure, consisting of merely five small-scale (&lt;10 MW) solar plants. Nevertheless, this is supported by larger power sources outside of the cluster via both extra high voltage and high voltage transmission infrastructure. This power distribution backbone generally covers the mapped ECRM occurrences well. There are, however, business opportunities to either construct new power stations or to expand the transmission network in support of ECRM-rich areas or of meaningful individual projects.</p> |

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| Communication | <p>Namibia has cellular coverage in most towns and road coverage along virtually all the major routes in the country, however, is mostly available up to 3G. Namibia's cellular network service providers are MTC and Telecom Namibia (TN Mobile). MTC is Namibia's leading mobile operator with a market penetration of 91 %. The company launched an expansion program worth US\$ 67 million in a bid to reach 100 % population coverage, including the installation of 554 new base stations. Telecom has a network of 296 mobile base-stations, of which several sites are equipped with 3G and 4G technology. Combined map of all cellular operators' towers in Namibia are concentrated along the Trans-Caprivi and Tripoli-Windhoek-Cape Town Highway corridors. Namibia connects to the Africa Coast to Europe (ACE) and West African Cable System (WACS) fibre optic networks via its landing station at Walvis Bay, with capacities of 20 Tbps and 14.5 Tbps, respectfully. Furthermore, Google's Equiano cable reached Namibia in 2022, enhancing the infrastructure with its capacity of 144 Tbps. Namibia has a terrestrial fibre network that interconnects all major towns with a point of presence. The country's fibre optic network has been extended to the country's borders with Angola, Zambia, Botswana, and South Africa to provide terrestrial access routes and network redundancy. Telecom Namibia and Paratus Namibia have been leading the way in constructing and upgrading Namibia's fibre network. Since 2020, Paratus has invested a total of NA\$ 150m (US\$ 10m) annually in terrestrial fibre infrastructure.</p> |
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**Table 97 Infrastructure assessment of Cluster 14: Namibia**

### 7.15 Cluster 15: Central and Eastern Africa (South)

|                                                      |                                              |
|------------------------------------------------------|----------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 25,822487, Y -13,424528                    |
| Area estimated                                       | 770,000 km <sup>2</sup>                      |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Cobalt, Manganese, Tin               |
| Country coverage                                     | Democratic Republic of Congo, Zambia, Angola |

#### 7.15.1 Location

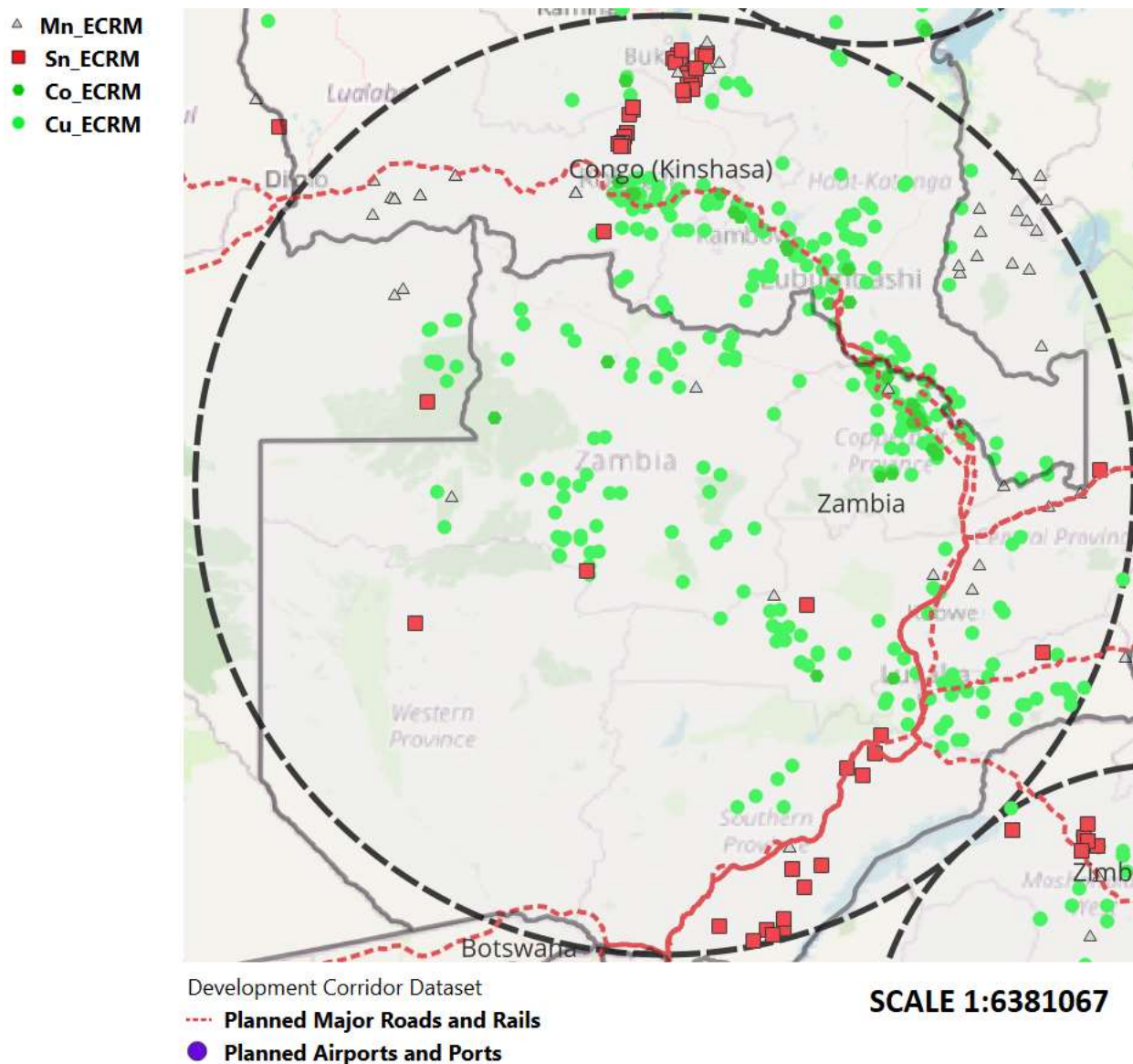


Figure 75 Location of Cluster 15: Central and Eastern Africa (South)

7.15.2 Summary

The cluster is centralised in Zambia, with portions of the DRC and Angola also captured, and is rich in copper, cobalt, manganese, and tin deposits. Zambia and Angola are considered politically stable, whereas the DRC is considered moderate. Relevant ASM activities exist in DRC and Zambia. The cluster contains a significant amount of large-scale mining operations due to the well-defined copper belt region along the Zambian-DRC border. Similarly, this is paired with suitable processing facilities and significant supporting infrastructure, such as roads and rails in these regions. In general, however, the cluster has poorly developed road infrastructure. The limited, yet vital network of development corridor highways is the lifeline of the region. Investments in maintaining these corridors is thus of utmost importance to a region so heavily influenced by the efficiency of transport channels. Road maintenance and development projects will thus ease the movement of goods inland and to ports. Rail infrastructure in the cluster follows the development corridors carved out by the roads. Although lacking coverage in the central and western region of the cluster, current railways, together with ongoing and planned development projects, should adequately serve the cluster. The Lobito Corridor Project is of particular interest in this region, where a joint interest of the EU and the US has seen investments flow into securing a linkage between the cluster’s ECRM rich regions and the Atlantic Coast. Business opportunities may exist, however, to establish the respective transport infrastructure (road/rail) to access the cluster’s ECRM potential in its central, underdeveloped region. The cluster’s power network is considerably developed along development corridors. Considerations should be made to expand the grid network to provide power to currently isolated areas. When doing so, renewable energy alternatives, and especially hydro energy, should be prioritised. The cluster is furthermore characterised by slow communication connections, where investments to support the development of fibre optic networks may be required. Key synergies are identified with the completed and ongoing works of the African Development Bank (AfDB), the Development Bank of Southern Africa, the World Bank, the Governments of Zambia, DRC, Angola, Tanzania, Malawi, Mozambique, and China, the European Investment Bank, and the EU. Cross-border development projects could interact with projects in cluster 12, 13, 14, 16 and 17.

7.15.3 Assessment

**Main investment needs:** Mining, processing, road, energy, communications.

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| Political stability | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in Zambia, and Angola, and moderate in the DRC. With respect to the African continent, Zambia is ranked 7 <sup>th</sup> , Angola 30 <sup>th</sup> , and the DRC 47 <sup>th</sup> of the 53-country dataset as of 2022. |
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| Artisanal Small-Scale Mining   | The DRC is a major and Zambia a medium-significance ASM producer for ECRM in Africa. ECRMs exploitation in both countries are covering cobalt, copper, rare earth elements, tantalum-niobium, tin, tungsten, manganese and in few areas PGE as well as additional non-ECRMs mainly gold, diamonds, gemstones, and lead-zinc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Mining                         | The cluster contains several large-scale mining sites, mostly located in the northeast. Large-scale mining is especially prevalent in the cluster throughout the copper belt near the Zambian-DRC border. Cobalt is also heavily mined in the region, whereas tantalum, tin, manganese, and nickel resources are also exploited. Although numerous large-scale mining activities exist in the region, a considerable amount of ECRM occurrences remain unexploited, especially copper and tin deposits. Exciting business opportunities thus exist to expand the mining sector in this region.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Processing facilities          | The cluster contains numerous processing plants, mostly servicing the vast copper activities (35). There are also several facilities to process cobalt (9) and sulphur (8), as well as single bismuth, germanium, iron ore, lead, and zinc facilities. Most installations are located near and served by existing power stations. Nevertheless, investments will be required with the expansion of the mining sector in the area with respect to the vast ECRM occurrences. Considerations should be made to the existing infrastructure available (power, road, rail), as well as the strategic importance of the intercepting development corridors.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Road / shipping infrastructure | The cluster's road infrastructure is limited and polarised around the eastern and northern borders. Road infrastructure comprises of primary (trunk) roads and secondary (national and regional) roads. Trunk roads connect larger cities, while national and regional roads disperse through cities and connect isolated regions. The Angolan portion of the cluster has extremely limited infrastructure, consisting solely of regional roads. Nevertheless, several development corridors intersect the cluster: (1) the North-South Corridor, (2) the Beira-Lobito Highway, (3) the Nacala Road Corridor, (4) the Trans-Capriivi Highway, (5) the Tanzam Highway, and (6) the Cairo-Gaborone-Cape Town Road, which serve as key gateways to external markets. Considering the (currently) vast inaccessible regions, road infrastructure, and especially the development corridors, still manage to provide sufficient access to many of the documented ECRM occurrences. However, given the region's coastal isolation and thus dependency on efficient transport channels, investments should be made into further developing the road network, as well as in maintaining and upgrading existing thoroughfares of strategic importance. |

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| Rail infrastructure | <p>Rail infrastructure follows the cluster's development corridors through Zambia and the DRC and are typically associated with areas of mineral wealth. No infrastructure is available in the western or central parts of the cluster. The North-South Railway connects to the port of Durban in South Africa via Zimbabwe.</p> <p>Benguela Railways (Caminho de Ferro de Benguela: CFB - 1,344 km) connects the port of Lobito in Angola to the eastern border-town of Luau and to the rail networks of south-western DRC. This line was rehabilitated in 2013 and is now fully operational. It is mostly used for the transport of minerals coming from the DRC and Zambia to be exported through the port of Lobito. This railway line forms part of the Lobito Corridor, a project heavily supported by the EU and the US due to its strategic importance. Both parties have heavily invested in the rail project in a bid to link the ECRM rich areas of the DRC and Zambia with the Atlantic coast. In particular, a feasibility study is currently underway to investigate the potential of a greenfields rail extension from Luacano (Angola) to Chingola (Zambia) via the bordering town of Jimbe (Zambia). Continued rehabilitation of the line from Lobito to Kolwezi remains a fundamental component of the concession. Agreements have also been made between the governments of Zambia and Tanzania to upgrade the interlinking TAZARA Railway to standard gauge, with a revamp worth US\$ 1bn proposed by China. Current rail infrastructure plans will sufficiently serve the clusters ECRM occurrences.</p> |
| Airports            | <p>Several major airports are found on the periphery of the cluster, namely: Harry Mwanga Nkumbula International Airport (Zambia), Kariba International Airport (Zimbabwe), Victoria Falls International Airport (Zimbabwe), and Luau Airport (Angola). These are supplemented by numerous heliports and smaller airports spread relatively homogeneously throughout the cluster. Synergies between the cluster's larger airports, smaller airports, and the development corridors should allow for sufficient transport of goods and personnel.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Ports               | <p>There are no ports in the inland cluster. The numerous development corridors, however, link the cluster to the ports of Lobito (Angola), Walvis Bay (Namibia), Dar es Salaam (Tanzania), Nacala (Mozambique), Beira (Mozambique), and Durban (South Africa). In line with the Lobito Corridor rail project, investments of approximately US\$ 110m will flow into upgrading and modernising the port of Lobito. Similarly, the Tanzanian Ports Authority recently signed a 30-year concession agreement with Dubai's logistics multinational DP World to upgrade the port of Dar es Salaam. This includes an initial investment of US\$ 250m during the first phase, and an overall projection of US\$ 1bn. The Malawian and Mozambique governments have agreed to build two dry ports in Sofala and Nampula province to support and promote the Beira Development Corridor. Furthermore, Mozambique, Malawi, and Zambia recently signed a tripartite agreement to revitalise the Nacala corridor. The cluster is adequately served by the surrounding ports.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |



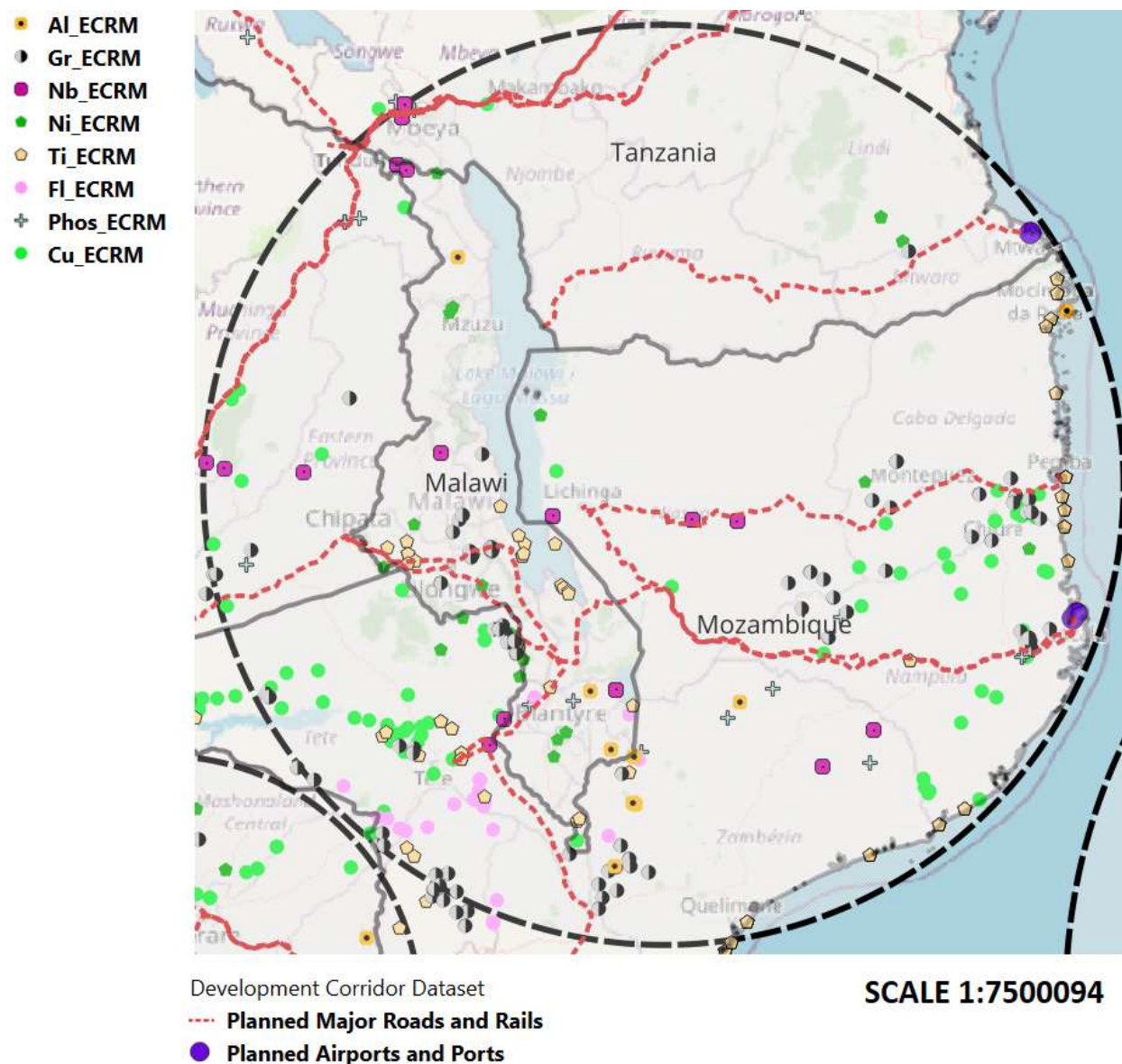
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| Energy        | <p>Power stations with generation capacities of 100-1000 MW and 10-100 MW are located near capital cities and along the cluster's development corridors. Smaller power stations with generation capacities &lt;10 MW are found in isolated regions in central and western parts of the cluster. Of the 37 power stations found within the cluster, 17 harness hydro energy, four solar energy, and two biomass, with the remainder stemming from non-renewable sources (diesel, coal, heavy fuel oil). The cluster's power distribution backbone similarly follows the development corridor network and interacts with power networks from neighbouring countries. As a result, most of the region's ECRM-rich areas have access to power. Business opportunities nevertheless exist to expand the grid network, as well as to harness more of the region's abundant hydro potential.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Communication | <p>There are no fibre landing cables in the cluster. However, the Eastern Africa Submarine System (EASSy), landed in South Africa, is 90 % African owned, with MTN, Vodacom, Neotel and Telkom being the largest operator investors. Zambia Telecom and Vodacom DRC also form part of this consortium. Significant mobile network providers in Zambia include MTN, Airtel, and Zamtel Mobile, providing up to 5G network coverage. However, coverage is highly limited to major cities, with poorer connectivity also available along the development corridors. The same applies for the DRC, with network coverage primarily supplied by Airtel, Africell, Vodacom, and Orange Mobile, providing services of up to 4G+ in major cities. Liquid Intelligence Technology's direct fibre link to West and East African countries has connected DRC to the 'One Africa' broadband network that links the African continent to the rest of the world. The Zambian Ministry of Science and Technology additionally plans to build a commercial data centre and extend the country's fibre optic network. Furthermore, Liquid Dataport (part of Liquid Intelligence Technology) has announced plans to expand its fibre backbone to connect Luanda, Angola and Lusaka, Zambia directly. Business opportunities exist to support such infrastructure development projects in the cluster.</p> |

**Table 98 Infrastructure assessment of Cluster 15: Central and Eastern Africa (South)**

## 7.16 Cluster 16: Eastern Africa (South)

|                                                             |                                                                                      |
|-------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>Coordinates (EPSG:4326 WGS 84)</b>                       | X 36,134250, Y -13,063619                                                            |
| <b>Area estimated</b>                                       | 1,010,000 km <sup>2</sup>                                                            |
| <b>Predominant ECRM occurrences (prospecting – deposit)</b> | Aluminium, Copper, Graphite Niobium-Tantalum, Nickel, Titanium, Fluorite, Phosphates |
| <b>Country coverage</b>                                     | Tanzania, Malawi, Mozambique                                                         |

### 7.16.1 Location



### Figure 76 Location of Cluster 16: Eastern Africa (South)

### 7.16.2 Summary

Tanzania, Malawi, and Zambia are considered politically stable, while Mozambique has been experiencing unrest, in particular due to insurgency (especially in the northernmost province of Cabo Delgado). The economic values of minerals to be mined in this cluster are profound, and together with the strategic geographic location, many business opportunities are available. ASM is significantly active in the mineral-rich areas, however, with some notable exceptions, not so much for the exploitation of ECRMs. Multiple large-scale mining projects exploiting ECRMs have gathered international attention, especially the significant graphite deposits in Tanzania and Mozambique. The cluster's ECRM potential has, however, merely scratched the surface. Investments will be needed to convert mineral exploration sites into operational projects, as well as in supporting ASM activities to scale up. Similarly, ECRM mineral processing facilities are also limited in the cluster. With the expansion of the ECRM mining sector, additional processing facilities will need to be constructed to support extraction activities. Synergies with the region's development corridors should be considered developing such facilities. Although limited in certain regions within the cluster, road and rail infrastructure adequately captures the numerous ECRM occurrences mapped thus far. Business opportunities exist to support the refurbishment of the Sena line of the Beira Railway. Furthermore, road and rail infrastructure corridors are well developed, providing strategic links to port facilities. The Nacala Road Corridor is one of the important trade corridors in Southern Africa and its development is critical to enhancing regional and international trade competitiveness, particularly for landlocked countries. These corridors are the lifelines of the cluster and are mostly funded and/or completed. Power generation and transmission infrastructure is reasonably developed within the cluster, shadowing the region's major development corridors. Power stations are irregularly scattered throughout the cluster, often harnessing renewable sources (hydro, solar, biomass) and connecting to the grid (plants >10 MW). Investments in both power generation and transmission infrastructure is recommended in the northern regions of Mozambique, particularly along the development corridors. Although a rapidly growing sector in all captured countries, telecommunications infrastructure is largely underdeveloped in the cluster. Investments to support the expansion of national fibre optic networks and mobile network stations will not only support potential ECRM projects, but will also improve the regions prosperity. Key synergies are identified with the completed and ongoing works of the African Development Bank (AfDB), the World Bank, the Governments of Tanzania, Malawi, Mozambique, Zambia, and China, the EU, and the private sector. Cross-border development projects could interact with projects in cluster 10, 12, 15 and 17.

### 7.16.3 Assessment

**Main investment needs:** Mining, processing, road, rail, energy, communications.

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | <p>According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in Zambia, Malawi, and Tanzania, and moderate in Mozambique. With respect to the African continent, Zambia is ranked 7<sup>th</sup>, Malawi 16<sup>th</sup>, Tanzania 20<sup>th</sup>, and Mozambique 41<sup>st</sup> of the 53-country dataset as of 2022.</p> <p>Two primary factors causing political instability in Mozambique are the lack of governance and the insurgency in the nation's northern territory, Cabo Delgado. Al-Shabab fighters attacked areas rich in precious stones in Mozambique's Cabo Delgado province, closing at least two mining operations and causing hundreds of people to flee villages in the Ancuabe and Montepuez districts.</p>                                                                         |
| Artisanal Small-Scale Mining | <p>Relevant ASM producer countries for ECRM in Africa are Tanzania and Mozambique. ECRMs exploited via ASM practices include mainly tin, tantalum, tungsten, copper and lithium beside non-ECRMs gold, gemstones, clay, sand, and precious and semi-precious stones.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Mining                       | <p>Industrial mining is present in all four countries, with operations currently found in Tanzania, Malawi, and Mozambique within the cluster. Coal mining has historically been the most prevalent in the cluster region, with multiple operations in Malawi and Mozambique. Nevertheless, CRMs are also being exploited by means of formalised large-scale mining practices, with deposits of copper, graphite, phosphate, tantalum, and titanium mined within the cluster. The region has especially been recognised for its profound graphite occurrences, with many such projects already gaining international attention (e.g., Nachu Graphite Project and Lindi Jumbo Graphite Project in Tanzania; Montepuez Mine and Balama Mine in Mozambique). The region, however, remains largely underdeveloped, presenting business opportunities to support the take-off of ECRM projects in the cluster.</p> |
| Processing facilities        | <p>The cluster contains numerous processing plants, mostly servicing industrial elements (cement and lime), as well as ECRM relevant facilities servicing their respective large-scale mining activities. Investments in additional processing facilities to support the take-off of the numerous ECRM occurrences in the region will be necessary. Synergies with the cluster's development corridors should be considered to harness the region's potential.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                            |

## Road / shipping infrastructure

Road infrastructure is moderately developed in the cluster. Primary (trunk) roads are well developed in Malawi, providing adequate coverage throughout the entire nation. Trunk roads, however, are scarce in the remainder of the cluster, where long, isolated stretches link the Ports of Lindi and Mtwara in Tanzania, and the port of Pemba in Mozambique, with larger, inland cities. These roads are moderately supported by secondary (national and regional) road infrastructure within the cluster, with the exception of Malawi. Nevertheless, the cluster boasts numerous development corridor projects, including: (1) the Cairo–Gaborone–Cape Town Road, (2) the Nacala Road Corridor, (3) the Tanzam Highway, (4) the Mtwara Development Corridor, and (5) the Pemba-Lichinga Corridor. These projects provide much needed infrastructure to improve transport efficiency and boost trade in the region. Additional projects include the construction of the Roma – Nambungale road in Mozambique, which aims to boost trade with Tanzania. The construction of the 164 km road cost was estimated at US\$ 170m and is financed by the African Development Bank. The Nacala Road Corridor is an important trade corridor in southern Africa and its development is critical to enhancing regional and international trade competitiveness, particularly for landlocked countries. The corridor extends from Lusaka in Zambia through Malawi and Mozambique to the port of Nacala. The Mtwara Development Corridor links the port of Mtwara to Mbamba Bay, of which the 804 km stretch to Songea has already been sealed. The onward route through Mbamba Bay via Mbinga remains to be completed. These projects will play an important role for current and potential ECRM projects. Nevertheless, business opportunities exist to improve regional road networks and to create access roads to currently isolated areas of ECRM wealth, e.g., fluorite occurrences in the cluster's southwest.

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| Rail infrastructure | <p>The cluster contains three separate railways: (1) the TAZARA Railway (Tanzania), (2) the Nacala Railway (Mozambique, Malawi), and (3) the Sena line of the Beira Railway (Mozambique, Malawi, Zambia). The TAZARA Railway spans 1,860 km and intersects the northern periphery of the cluster, linking the Port of Dar es Salaam (Tanzania) with Kapiri Mposhi (Zambia). Agreements have been made between the governments of Tanzania and Zambia to upgrade the interlinking TAZARA Railway to standard gauge. China recently submitted a US\$ 1bn proposal to revitalise and upgrade the entire railway segment. The Nacala Railway Corridor operates in northern Mozambique on a 912 km line that runs west from the port city of Nacala, crossing the central region of Malawi (via. Nkaya), connecting with the coal belt of Moatize in northwest Mozambique. It furthermore includes a stretch from Cuamba to Lichinga, creating a link with the Pemba-Lichinga Corridor. The project was spearheaded by the Brazilian mining company 'Vale' in partnership with the Mozambique Ports and Railway (CFM) company, costing a total of US\$ 4.4bn. The Sena line of the Beira Railway links the port of Beira (Mozambique) with Chipata (Zambia) via Malawi. The line has been in a state of severe degradation between Blantyre and Nhamayabué due to flood damages in 1997. However, the Mozambiquan and Malawian governments have issued for the restoration of the line to re-establish the most direct route from Lilongwe/Blantyre to the port of Beira. Current rail infrastructure should adequately serve the region's ECRM potential. Supporting investments in the refurbishment of the Sena line of the Beira Railway may be necessary.</p> |
| Airports            | <p>The cluster contains three international airports, namely: (1) Lilongwe International Airport, (2) Blantyre Chileka International Airport, and (3) Nacala International Airport. The two former airports are situated in Malawi, while the latter is found in Mozambique. They are all well connected by road and rail infrastructure, holding strategic positions well-situated to the cluster's development corridors. The Malawian airports underwent a joint rehabilitation program worth US\$ 4.8m, funded by the European Investment Bank. Nacala International Airport was heavily redeveloped for commercial use, a project worth an estimated US\$ 150m funded by the Brazilian Development Bank. Since commercial practices began in 2014, the airport has been operating at an extremely reduced capacity (ca 10 %). This available capacity, along with existing synergies with the port of Nacala and the Nacala Development Corridor, holds great potential for the cluster. Numerous small, regional airports sufficiently supplement the larger airport infrastructure, and in cooperation with existing road and rail infrastructure, should sufficiently serve the cluster.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |



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| Ports  | <p>Cluster 16 contains four ports, namely: (1) Mtwara (Tanzania), (2) Pemba (Mozambique), (3) Nacala (Mozambique), and (4) Quelimane (Mozambique). It is also served by the external ports of Dar es Salaam (Tanzania) and Beira (Mozambique) by means of development corridors. Mtwara is one of the three major ports managed by Tanzania Ports Authority, developed along the southern Tanzanian coast near the border with Mozambique. The deep-water port forms part of the Mtwara Development Corridor and links the rich southern Tanzanian region with international markets. Completion of the US\$ 61m Mtwara port expansion project happened in 2020, however further developments are being discussed to allow for an export-processing zone. This will improve the regional economy and increase revenue from the port. The port of Pemba was in recent years subject to a US\$ 5m rehabilitation and modernisation program. After undergoing refurbishment and currently operating at full capacity, the port of Nacala now has the capacity to handle 10 million t of cargo per year. The port is located in northern Mozambique and provides an important access route for imports and export cargo from Malawi and Zambia. Supported by Japan International Cooperation Agency (Jica), the port was expanded over two phases at a total cost of US\$ 248.3m. Mozambique Ports and Railways (CFM) needs just over US\$ 5.3m to ensure more effective and deeper dredging of the port of Quelimane, in Mozambique's Zambézia province, to allow for the entry of large draft ships. Business opportunities exist to support this effort and unlock a gateway for potential ECRM projects in the cluster's south.</p> |
| Energy | <p>Power stations are irregularly spread throughout the cluster and concentrated especially in the southwest region and along development corridors. Of these, the Cahora Bassa hydroelectric plant at the Zambezi River basin in Mozambique is the largest, with a generation capacity of 2,075 MW. The hydropower project consists of five turbines, each with 415 MW nameplate capacity. Power stations with generation capacities ranging between 100-1000 MW are found near Blantyre in Malawi (hydro), Nacala in Mozambique (heavy fuel oil), and at the Kihansi Dam (hydro) in Tanzania. These larger power stations are supplemented by medium plants (10-100 MW), harnessing a combination of renewable (hydro, solar, biomass) and non-renewable sources. The large-medium power stations in the cluster are all connected to the grid, with one exception. Smaller power stations with generation capacities &lt;10 MW are most abundant, of which approximately half are installed off-grid. Similarly, these smaller stations harness a combination of renewable (27) and non-renewable (15) sources, with hydro being most prevalent. The power transmission network in the cluster shadows road and rail infrastructure, with the main exceptions of the Mtwara and the Pemba-Lichinga Development Corridors. As such, current infrastructure well captures the cluster's ECRM distribution. Nevertheless, business opportunities exist to develop and electrify Mozambique's Cabo Delgado, Nampula, and Niassa regions, especially along the Mtwara and the Pemba-Lichinga Development Corridors.</p>                                                                                                               |

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| Communication | <p>Cluster 16 does not contain any fibre hubs, however landing stations in Dar es Salaam (Tanzania) and Maputo (Mozambique) provide the cluster with access to the following international submarine fibre optic cables: Africa-1, Eastern Africa Submarine System (EASSy), Liquid Sea, and SEACOM. Data infrastructure in Tanzania has improved significantly through investments in the fibre-optic network. There has also been investment in local internet exchange points, migration to internet protocol version 6 (IPv6), and construction of the National ICT Broadband Backbone (NICTBB). However, terrestrial fibre optic infrastructure is lacking in large portions of the cluster. Malawi is equipped with a solid national fibre optic backbone, while northern Mozambique and southern Tanzania remain largely underdeveloped. Investments will thus be required to support the expansion of fibre optic networks in the cluster.</p> <p>According to Bowmans, Tanzania is the second-largest telecoms market in East Africa behind Kenya. Significant mobile operators in Tanzania include Vodacom, MIC, and Airtel Tanzania, although network coverage is extremely limited to the cluster region. Mobile providers in Mozambique include Movitel, Tmcel, and Vodacom, providing services of up to 4G+ within the clusters. Networks are extremely polarised and are mostly limited to larger cities (e.g., Nacala, Tete) and along stretches of development corridors. Mobile providers in Malawi include Airtel Mobile and TNM Mobile, providing services of up to 4G+. Malawi has a significant national telecommunications network. A strong increase in telecom subscribers base has necessitated network expansion covering a wider area, thereby creating a need for significant investment in telecom infrastructure. Business opportunities exist to support the development of the telecommunications market within the cluster. Such investments will have positive downstream effects on the region's potential ECRM projects.</p> |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Table 99 Infrastructure assessment of Cluster 16: Eastern Africa (South)**

## 7.17 Cluster 17: Zimbabwe

|                                                      |                                        |
|------------------------------------------------------|----------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 30,603895, Y -18,903742              |
| Area estimated                                       | 310,000 km <sup>2</sup>                |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Lithium, Nickel, Tin, Tungsten |
| Country coverage                                     | Zimbabwe                               |

### 7.17.1 Location

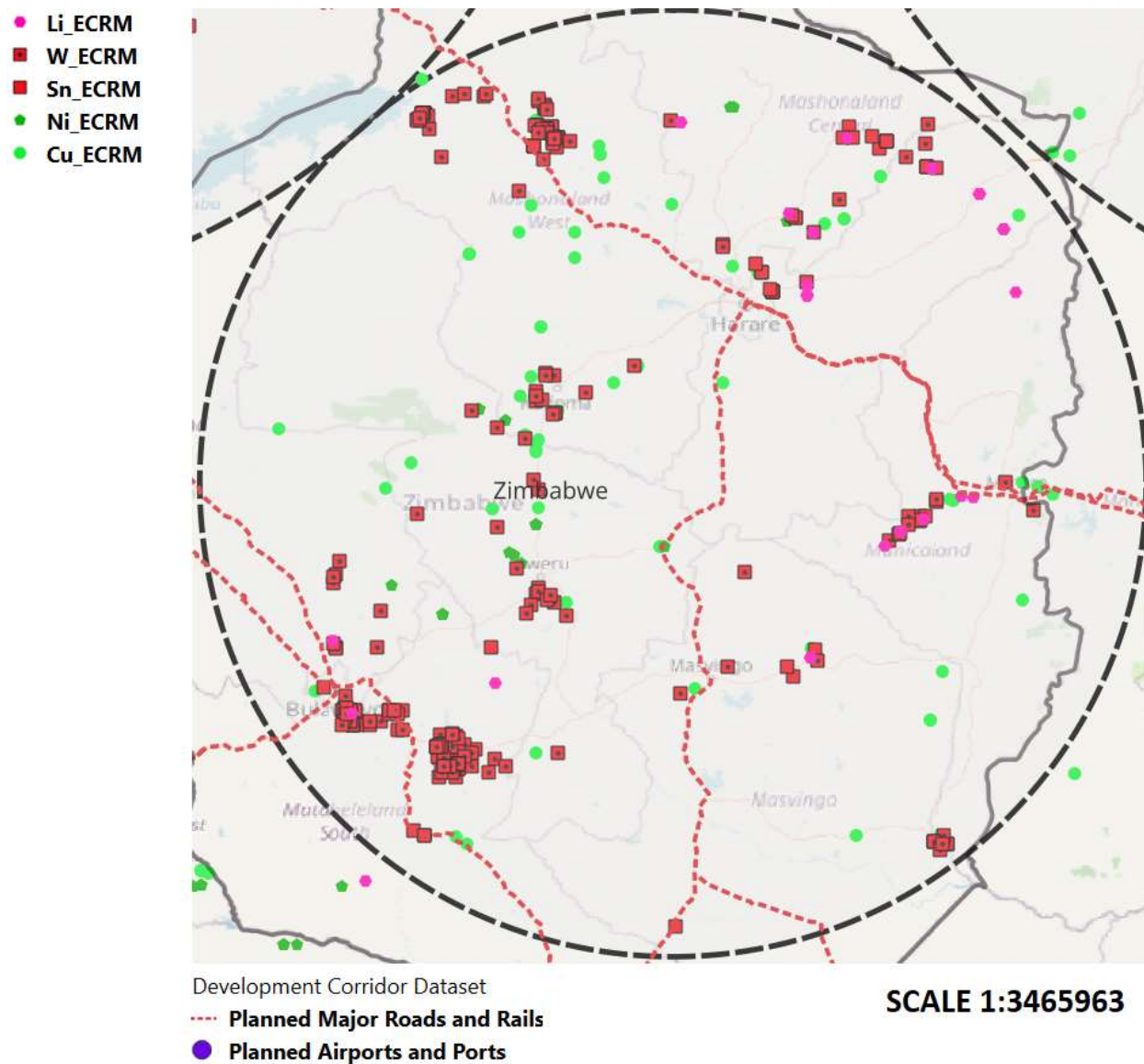


Figure 77 Location of Cluster 17: Zimbabwe

7.17.2 Summary

The cluster is found within Zimbabwe and contains copper, lithium, nickel, tin, and tungsten occurrences. Zimbabwe is considered a politically stable country. ASM activities are practiced in the country, with tin, tantalum, tungsten and lithium being exploited. The cluster contains several mining and mineral processing facilities, however the ECRM mining landscape remains underdeveloped, although there is significant lithium potential in Zimbabwe. Investments in supporting the take-off of ECRM mining projects and their respective processing facilities will be needed. Road infrastructure is adequately developed in the cluster, with most of the mapped ECRM occurrences currently (near) accessible. Significant development (road) corridors in this cluster are Beitbridge-Victoria Falls-Harare Road (under rehabilitation), Beira-Lobito Highway (undergoing upgrade), and Cairo-Gaborone-Cape Town (operational). The development corridors are conveniently located proximal to CRM hotspot and could therefore be used as an opportunity for regional trade. The cluster’s rail infrastructure is well-situated to the documented ECRM occurrences and provide strategic links to the ports of Beira and Maputo in Mozambique, and Durban in South Africa. However, a lack of maintenance and funding has resulted in the gradual degradation of the Zimbabwean network, where investments will be needed for its restoration and modernisation. The ports of Beira and Maputo in Mozambique are the nearest and most accessible to the cluster. Planned and ongoing expansion works in both ports should sufficiently serve the cluster’s trade needs. Zimbabwe boasts an already well-developed communications network, with large-scale developments of its communications and fibre optic networks currently underway. Key synergies are identified with the completed and ongoing works of the African Development Bank (AfDB), the World Bank, the Development Bank of Southern Africa, the Governments of Zimbabwe, Mozambique, and China, the European Investment Bank, as well as the private sector. Cross-border development projects could interact with projects in cluster 15, 16 and 18.

7.17.3 Assessment

**Main investment needs:** Mining, Processing, Road, Rail, Energy.

|                     |                                                                                                                                                                                                                                                                                           |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in Zimbabwe. With respect to the African continent, Zimbabwe is ranked 36 <sup>th</sup> of the 53-country dataset as of 2022. |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Artisanal Small-Scale Mining   | Zimbabwe is a relevant ASM producer country for ECRM in Africa. ECRMs exploited via ASM practices include lithium and, to a lesser degree, tin, tantalum and tungsten, beside non-ECRMs gold, emeralds and chromite.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Mining                         | The cluster contains numerous mining activities and already exploits the following ECRMs: cobalt (8), copper (8), graphite (1), lithium (1), nickel (8), phosphate (1), PGEs (6), and titanium (1). Nevertheless, the cluster's ECRM mining landscape boasts great potential for expansion, especially for the vast and densely populated tungsten occurrences. Existing infrastructure and development corridors servicing the semi-established mining sector present good business opportunities for the ECRM mining sector.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Processing facilities          | Available data indicates that at least 31 mineral processing facilities are available within the cluster. These primarily consist of iron and steel processing and refining facilities (12), but also for the following ECRMs: bauxite (1), cobalt (2), copper (1), nickel (2), phosphate (1), and PGEs (4). Investments in additional processing facilities will be necessary to service the expansion of the ECRM mining sector. Considerations should be made to areas with high densities of similar mineral occurrences, e.g., tungsten occurrences in the southwest region of the cluster, where larger processing facilities may be erected to serve multiple operations (where possible).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Road / shipping infrastructure | Zimbabwe boasts a total of 88,100 km of roadways, of which 17,400 km are paved. Primary (trunk) roads provide adequate coverage throughout the cluster, primarily from branching outwards from the capital city of Harare (Zimbabwe). This backbone is substantially supplemented by secondary (national and regional) roads, such that nearly all of the cluster's mapped ECRM occurrences are already accessible. Significant development corridors in this cluster are Beitbridge-Victoria Falls-Harare Road (under rehabilitation), Beira-Lobito Highway (undergoing upgrade), and Cairo-Gaborone-Cape Town (operational). The Beitbridge-Victoria Falls-Harare Road connects Harare in the cluster's centre with the border of South Africa, while the Beira-Lobito Highway connects the northwest region of the cluster to the port of Beira on the Indian Ocean via Harare. Road transport is the dominant means of transport in Zimbabwe, by which most of the nation's traffic and trade (80 % by volume) is transported. Nevertheless, a lack of financial resources to maintain and rehabilitate the road networks has resulted in their gradual degradation. Business opportunities exist to rehabilitate and modernise strategic road segments with respect to the location of ECRM occurrences. Such investments should consider synergies with existing rail infrastructure, so as to relieve the already strained road networks. |

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|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rail infrastructure | <p>The cluster contains significant rail infrastructure, all of which is managed by the state-owned National Railways of Zimbabwe (NRZ) enterprise. Existing infrastructure is conveniently located to most of the cluster's ECRM occurrences, with some exceptions in the northern region. Significant lines include the Beira–Bulawayo railway, connecting the cluster's southwest with the port of Beira (Mozambique) via Harare, the Bulawayo-Chicualacuala line, where access to the port of Maputo in Mozambique is obtained, and the North-South Rail corridor. Both the Zimbabwean and the Mozambican presidents have inaugurated the renovation of the Beira-Machipanda railway line. The rehabilitation of the railway is to ease traffic at the Forbes Border Post in Mutare, which usually ranges between 300 to 500 trucks per day. The Beira Railway project aims to facilitate efficient freight transportation from Zambezi Valley to the Beira Railway System. In the cluster's south, the North-South Rail corridor links Zimbabwe to the port of Durban in South Africa, while the Limpopo railway links Zimbabwe's Bulawayo-Chicualacuala line to the port of Maputo in Mozambique. The rail sector in Zimbabwe is in dire need of recapitalisation as the wagons, locomotives, tracks, and signalling systems are all outdated and in need of replacement. Investments to rehabilitate and modernise the cluster's already broad rail network will largely benefit potential ECRM projects and help boost trade in the region.</p> |
| Airports            | <p>The cluster contains three international airports, namely: (1) Robert Gabriel Mugabe International Airport in Harare, (2) Joshua Mqabuko Nkomo International Airport located in Bulawayo, and (3) Masvingo International Airport in Masvingo. The Robert Gabriel Mugabe International Airport recently underwent a US\$ 153m upgrade funded by the China Export-Import Bank, including the construction of a new terminal building and two new aprons to accommodate four new air bridges. Joshua Mqabuko Nkomo International Airport planned to commence construction a new air traffic control tower and fire station worth US\$ 13m. International airports are heavily supported by smaller, regional airports throughout the entire cluster. Current infrastructure and ongoing projects will adequately serve the cluster.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |



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| Ports  | <p>There are no ports within the cluster. Significant ports accessible to the cluster by rail and road networks include the port of Beira and the port of Maputo in Mozambique, and the port of Durban in South Africa. The port of Beira is the most accessible port to the cluster linked by the Beira Railway and the Beira-Lobito Highway. Port Maputo is the largest and most developed port in Mozambique and is accessible via the Limpopo railway line. The concession of all ports is taken over by the state-owned port and rail company, Portos e Caminhos de Ferro de Moçambique (CFM). The government of Mozambique has recently approved a deal for the US\$ 2bn expansion of Maputo Port, which aims to double annual cargo handled by 2058. Furthermore, the Mozambican government announced its intention to invest US\$ 290m in the expansion and modernisation of the port of Beira, including an increased capacity of container handling, general cargo, and storage facilities. The port of Durban may also serve the cluster via the North-South Rail corridor, should trade volumes be strained at the closer Mozambiquan ports. External port infrastructure and their ongoing/planned expansions will adequately serve the cluster.</p>                                       |
| Energy | <p>The cluster contains relatively few power stations. Munyati Power Station, a five-unit coal-fired power plant, is the cluster's largest power station with a generation capacity of 100 MW. This is supplemented by seven medium-size plants with generation capacities ranging between 10-100 MW found near cities and processing plants. The remaining 23 plants in the cluster are smaller (&lt;10 MW) and stem solely from renewable sources. Of these, eight hydro plants are not connected to the grid. Power is furthermore sourced from outside of the cluster region, with the Cahora Bassa hydroelectric plant at the Zambezi River basin in Mozambique being the most significant, with a generation capacity of 2,075 MW. The power distribution network is adequately established, with extensive extra high voltage infrastructure spanning the cluster. There are several planned grid lines connecting both Mozambique and Zimbabwe. Investments can be made in the distribution of energy via power lines by the border between Mozambique and Zimbabwe to supply ECRM hotspots. Business opportunities also exist to extend the coverage and quality of the power distribution network in the tungsten-rich region in the cluster's southwest (pending project feasibilities).</p> |

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|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Communication | <p>Zimbabwe’s information and communications technology (ICT) mobile services include NetOne, Telecel, and Econet, providing network coverage of up to 4G+. Econet is the nation’s largest telecommunications and technology provider and has recently invested US\$ 66m in network modernisation, including the upgrading and construction of existing and new base stations, respectfully. The four Internet Access Providers in Zimbabwe are Africom Zimbabwe, Powertel Communications Pvt Ltd (a subsidiary of Zimbabwe Electricity Supply Authority), DataOne (owned by TelOne), and Broadlands Networks Ltd. The landlocked nation is connected to cross-border fibre optic networks (e.g., South Africa, Mozambique, Tanzania) and has recently invested largely into the expansion of its terrestrial network. Bandwidth and Cloud Services Group (BCS) have been tasked to implement the US\$ 18m project, of which the first stage of the national rail fibre optic project (1,180 km of fibre) is now complete.</p> |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

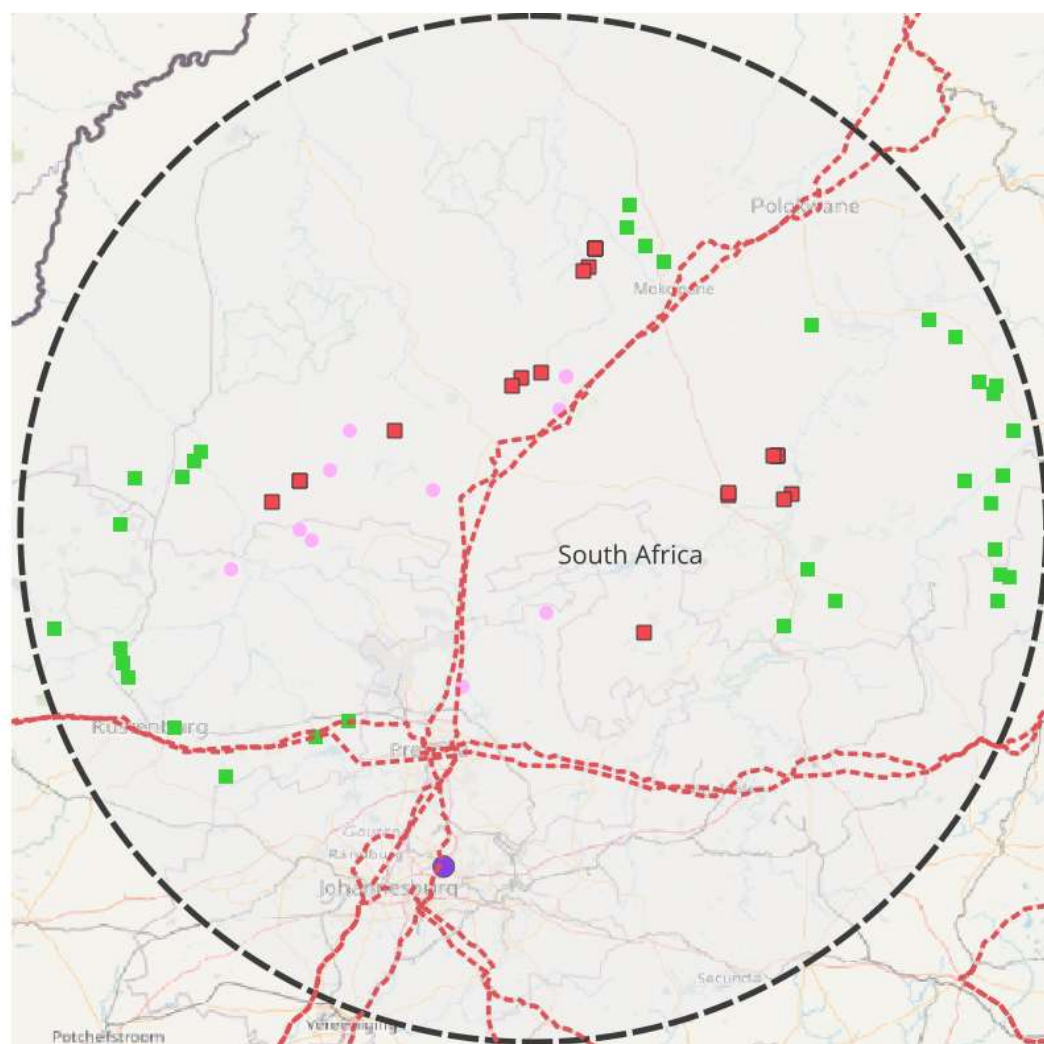
Table 100 Infrastructure assessment of Cluster 17: Zimbabwe

### 7.18 Cluster 18: South Africa (North)

|                                                      |                                        |
|------------------------------------------------------|----------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 28,539794, Y -24,997451              |
| Area estimated                                       | 118,000 km <sup>2</sup>                |
| Predominant ECRM occurrences (prospecting – deposit) | Tin, Fluorite, Platinum Group Elements |
| Country coverage                                     | South Africa                           |

#### 7.18.1 Location

- Sn\_ECRM
- Fl\_ECRM
- Pltd\_ECRM



Development Corridor Dataset

SCALE 1:1946561

--- Planned Major Roads and Rails

● Planned Airports and Ports

Figure 78 Location of Cluster 18: South Africa (North)

### 7.18.2 Summary

The cluster is located in the Gauteng province in the north-eastern parts of South Africa. It is rich in tin, fluorspar, and palladium occurrences. ASM activities for ECRMs are insignificant in this region. Large scale mining is widely adopted in the region, whereby 50 % of documented operation engage in the exploitation of ECRMs. Accordingly, ECRM processing facilities are also widely available in the cluster. Investments will be required to support the take-off of ECRM projects and for the processing facilities associated. The road and rail networks in this cluster are significantly developed, providing extensive coverage throughout the cluster's south, as well as access to nearly all the documented ECRM occurrences. Energy capacity in the region is very large, though reliable energy supply remains problematic. Business opportunities exist to develop the power network in the cluster's centre to provide power access to potential ECRM projects. Several roadways and railways form part of the development corridors, linking port facilities and enabling regional trade in the Southern African region. Business opportunities exist to support ongoing and planned railway infrastructure projects in and around the cluster. Additionally, supporting investments in green energy, in line with the green energy development in the country, will have large regional benefits. Key synergies are identified with the completed and ongoing works of the African Development Bank (AfDB), the Development Bank of Southern Africa, the World Bank, as well as the private sector. Cross-border development projects could interact with projects in cluster 17.

### 7.18.3 Assessment

**Main investment needs:** Mining, processing, rail, energy.

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in South Africa. With respect to the African continent, South Africa is ranked 32 <sup>nd</sup> of the 53-country dataset as of 2022.                                                                                                                                                                                                                                                                                              |
| Artisanal Small-Scale Mining | South Africa is no relevant ASM producer country for ECRM in Africa, however South Africa has several artisanal miners focusing on non-ECRM gold, diamonds, gemstones, limestones, coal, dimension stones, salt, sand, silver, and talc.                                                                                                                                                                                                                                                                                                                                                       |
| Mining                       | The mining landscape is already well established in the cluster area, with available data recording at least 206 mines. Commodities extracted are differentiated into fuels (25 %), gemstones (1 %), industrial minerals (4 %), and metals (69 %), of which ECRM extraction accounts for 50 % of all projects. CRM minerals extracted by large-scale mining practices include fluorspar, antimony, cobalt, copper, PGEs, and vanadium. Business opportunities exist to support the expansion of PGE mining in the region, as well as to capitalise on the untapped tin and fluorite potential. |

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Processing facilities          | There are 79 documented processing facilities in this cluster. Existing processing facilities cater for gemstones (1 %), fertilizer (1 %), industrial minerals (13 %), and metals (85 %). 56 % of processing infrastructure serves the following ECRMs: silicon, cobalt, copper, PGEs, and vanadium. Processing facilities are located nearby respective mining operations and have sufficient access to power. Investments for additional facilities will be required when additional ECRM projects pass feasibility and turn operational.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Road / shipping infrastructure | Engulfing both Johannesburg and Pretoria, the cluster's road infrastructure is well established, consisting of vast networks of primary (freeway and trunk) and secondary (national and regional) roads. Nevertheless, infrastructure is significantly more developed around urban areas in the cluster's south, whereas the cluster's northern hemisphere remains underdeveloped. However, the cluster's road network provides almost complete accessibility to the documented ECRM occurrences. Road infrastructure overlaps with several development corridors, namely: the Maputo Development Corridor, the North-South Corridor, and the Trans-Oranje Corridor. The Maputo Corridor connects the northeastern provinces of South Africa to the port of Maputo in Mozambique. It runs through industrialised Southern African regions and includes several road projects including the N4 national highway. The South Africa Corridor Road links ports in Durban and Cape Town to the Gauteng province. It includes N1 (Cape Town to Beit Bridge), N2 (Cape Town to Ermelo), and N3 (Cape Town to Johannesburg) national highways. Business opportunities exist to improve roadways from ECRM rich areas to create more efficient transport links. |
| Rail infrastructure            | South Africa has an extensive rail infrastructure. Similar to roadways, rail infrastructure is much more prevalent in the cluster's southern hemisphere. Significant rail corridors intersecting the cluster include the North South Railway Corridor (operational) and the Maputo Railway Corridor (operational). The North South Railway Corridor passes vertically through the entire cluster and links it with the Port of Durban in South Africa. The Maputo Railway Corridor links the industrial Gauteng province (Pretoria) with Mozambique's largest port. The African Development Bank is financing the purchase of US\$ 40m of locomotives and wagons and another US\$ 30m is under consideration from the Development Bank of Southern Africa for improvements on the line that connects the Port of Maputo with South Africa. Although South Africa has vast rail linkages, its rail and port capacity declines are major constraints for regional trade. The government of South Africa plans to spend ZAR 900bn (US\$ 48bn) on rail infrastructure by 2027, although regulatory and organisational challenges continue to delay progress.                                                                                               |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Airports | <p>The cluster has four major airports: (1) O.R. Tambo International Airport, (2) Pilanesberg International Airport, (3) Lanseria International Airport, and (4) Polokwane International Airport. South Africa's Airports Company (Acsa) has invested ZAR 21.7bn (US\$ 1.1bn) for airport infrastructure development, of which a significant portion will be directed towards the O.R. Tambo International Airport in Johannesburg. The project entails the construction of a new cargo terminal, the Mid-field Cargo facility, and the expansion of the bussing gates at Terminal A. Smaller, regional airports adequately supplement the larger international airports. Similar to the cluster's rail and road development, airport infrastructure in the southern hemisphere is significantly more developed. However, synergies between the cluster's vast aviation facilities and terrestrial transport infrastructure will adequately serve the ECRM occurrences in the cluster.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Ports    | <p>There are no ports within the cluster. The most accessible ports include (1) the port of Maputo in Mozambique, and (2) the ports of Durban and (3) Richards Bay in South Africa. Development corridors link the cluster to additional ports (e.g., Cape Town, Walvis Bay, Beira), however, large distances may strongly impact their feasibility. The government of Mozambique has recently approved a deal with DP World for the US\$ 2bn expansion of Maputo Port, which aims to double annual cargo handled by 2058 (over a 25-year concession period beginning in 2033). South Africa's main container port is Durban, which accommodates dry bulk, liquid bulk, automotive, and break bulk. It is the largest and busiest port in Sub-Saharan Africa (Africa's second largest) and handles up to 81.2 million t of cargo annually (2019). Transnet Port Terminals manages all of South Africa's ports and has recently issued a request for proposals for the reconstruction, deepening, and lengthening of two berths at the Durban Container Terminal. The berth deepening project will help expand the port of Durban's throughput from the current 2.7 million TEUs to 4.5 million TEUs over the next 10 years. This is part of a ZAR 154bn (US\$ 8.3bn) KwaZulu-Natal (KZN) Ports Master Plan to transform the facilities into an international container hub. The port of Richards Bay has 13 deep water berths and is the bulk port of choice in the Southern African region. Funding from the Development Bank of Southern Africa (DBSA) will go towards developing a common-use infrastructure facility for the LNG terminal.</p> |



|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Energy        | <p>The cluster boasts significant power generation and transmission infrastructure. Similar to other infrastructure development in the region, the cluster's south is significantly more developed. The cluster hosts seven power stations with generation capacities exceeding 1000 MW, six power stations with generation capacities between 100-1000 MW, six power stations with capacities between 10-100 MW, and 66 small-scale (&lt;10 MW) power stations. Renewable energies are frequently harnessed among smaller power stations, accounting for 81 % of power stations with capacities &lt;100 MW. Of these, solar energy is the most adopted and available resource. Extra high voltage power transmission infrastructure is broadly adopted, spanning much of the cluster area. Power is available to many of the mapped ECRM occurrences; however, investments may be required to electrify the region containing fluorite and tin occurrences in the cluster's centre.</p> <p>42,000 MW of South Africa's electricity is generated via coal-fired power stations. About 95 % of the electricity is generated by the state-owned and vertically integrated power company, Eskom. To attract renewable energy into the country, an independent power producer program, the Renewable Energy Independent Power Producer Procurement (REIPPP), has been introduced. The country has ongoing power outages referred to as "load-shedding". It has developing non-hydro renewables with 8.7 GW of renewable energy planned to be installed between 2023 and 2032. Business opportunities exist to support the development of non-hydropower renewables.</p> |
| Communication | <p>The Africa-1 submarine fibre cable has a landing point in South Africa. It is owned by PCCW, Saudi Telecom, MTN Group, Telecom Egypt, and Telkom South Africa. The Eastern Africa Submarine System (EASSy) is owned by Botswana Fibre Networks, Telkom South Africa, Sudan Telecom Company, Telma (Telecom Malagasy), Tanzania Telecommunications Company Limited, Zambia Telecom, Mauritius Telecom, Vodacom DRC, MTN Group, Comores Telecom, Neotel, BT, Etisalat, and Sau. This cable is 90 % African owned with MTN, Vodacom, Neotel, and Telkom being the largest operator investors. South Africa also has a landing point for SEACOM/Tata TGN-Eurasia communications. Terrestrial fibre optic infrastructure is well developed in the cluster. Dark Fibre Africa (DFA) began its ZAR 400m (US\$ 21.3m) fibre network infrastructure expansion project in South Africa in 2023. Significant mobile providers are MTN, Cell C, Telekom, and Vodacom, providing network coverage of up to 5G in the cluster. Telecommunications infrastructure is sufficiently developed in the cluster region.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

**Table 101 Infrastructure assessment of Cluster 18: South Africa (North)**

### 7.19 Cluster 19: South African Coast (West)

|                                                      |                            |
|------------------------------------------------------|----------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 18,354356, Y -28,507082  |
| Area estimated                                       | 96,000 km <sup>2</sup>     |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Tungsten, Fluorite |
| Country coverage                                     | Namibia, South Africa      |

#### 7.19.1 Location

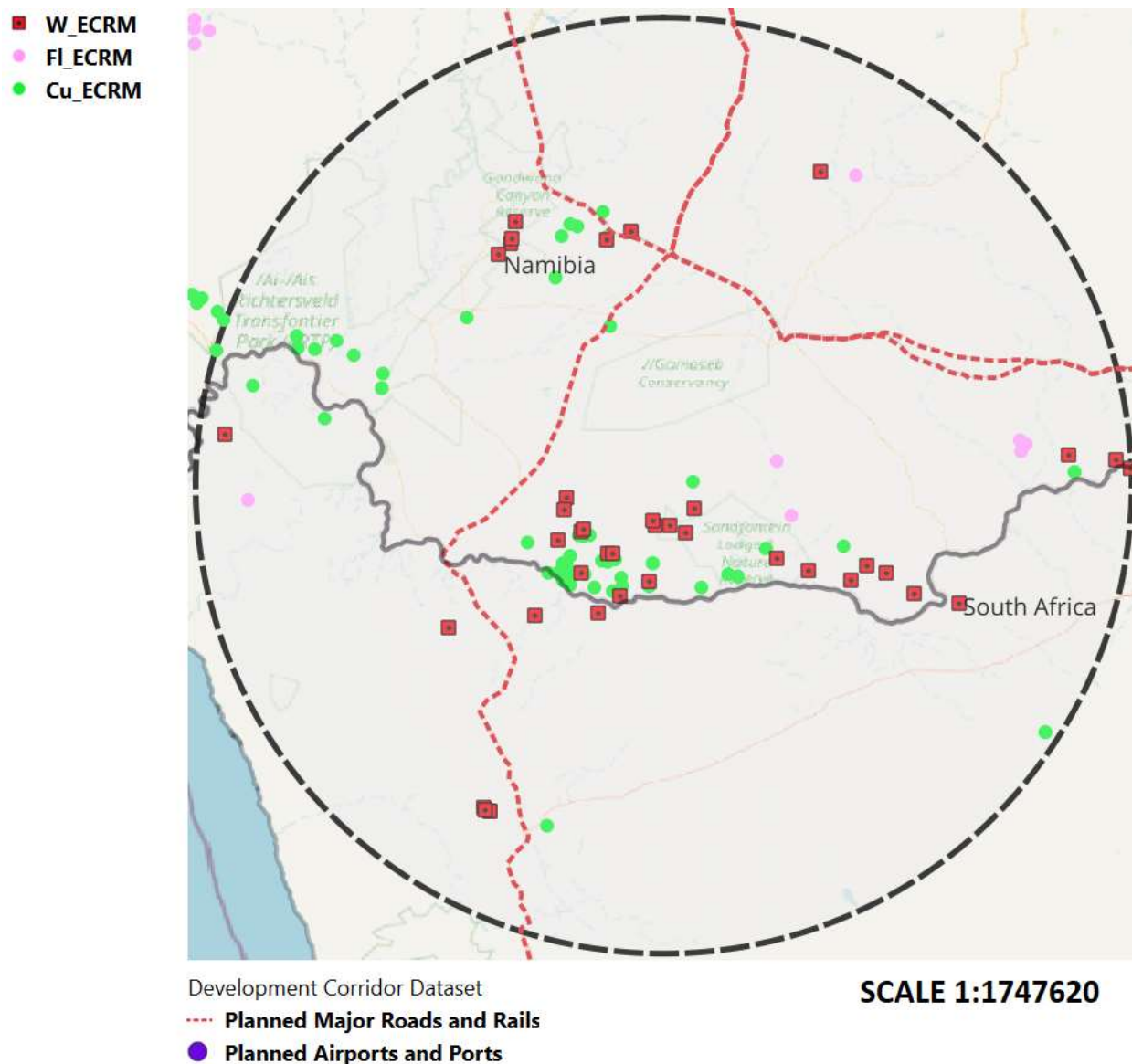


Figure 79 Location of Cluster 19: South African Coast (West)

### 7.19.2 Summary

The cluster is found along the South African-Namibian border and is rich in copper, tungsten, and fluorspar occurrences. Namibia and South African are considered politically stable countries. Significant "small-scale mining" (SSM) activities for ECRM are generally found in Namibia. The cluster contains few documented mining activities, including one copper mine. No processing facilities are found in the cluster. Business opportunities exist to support the take-off of potential ECRM projects and their respective processing facilities. Road infrastructure is limited in the cluster, with many of the ECRM occurrences currently inaccessible. Primary (trunk) roadways include the Tripoli–Windhoek–Cape Town Highway (TAH-3) and the Trans-Oranje Road development corridor highways. Investments will be needed to develop strategic roadways through the ECRM-rich areas along the international border. Similarly, rail infrastructure is very limited in the cluster, consisting of a stretch of the Trans-Oranje Railway, which links the cluster with the ports of Lüderitz and Walvis Bay in Namibia. Considerations may be made into establishing a rail link from the cluster to existing rail lines in South Africa. There are no international airports and only few smaller, regional airports in the cluster. Investments to support the construction of remote airfields serving ECRM projects/regions may be required. Most of the country's energy needs are supplied by South Africa's state-owned energy entity, Eskom. Power generation infrastructure is scarce. Business opportunities exist to support the expansion of the renewable and/or green energy sector, as well as to further develop the grid network. Both nations have well-established information and communications technology sectors, however, the cluster region remains relatively underdeveloped. Investments may be required to improve mobile network coverage in the cluster, especially in Namibia. Key synergies are identified with the completed and ongoing works of the African Development Bank (AfDB), the Development Bank of Southern Africa, as well as the private sector. Cross-border development projects could interact with projects in cluster 14.

### 7.19.3 Assessment

**Main investment needs:** Mining, processing, road, rail, airports, energy, communications.

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism, is perceived as low in Namibia and South Africa. With respect to the African continent, Namibia is ranked 6 <sup>th</sup> and South Africa 32 <sup>nd</sup> of the 53-country dataset as of 2022.                                                                                                                           |
| Artisanal Small-Scale Mining | The term "small-scale mining" (SSM), as opposed to ASM, is used in Namibia, a minor small-scale mining (SSM) producer country for ECRMs in Africa. Small-scale mining (SSM) refers to mining with minimal machinery and/or simple technology with very low capital requirements. ECRMs exploited via small-scale mining (SSM) practices include copper, tin, tantalum, fluorspar, and lithium, as well as non-ECRMs like semi-precious stones and dimension stones. |

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mining                         | There are six mining operations in this cluster: copper (1), diamond (1), lead (1), silver (1), and zinc (2). Several diamond mining operations are located nearby the periphery of the cluster along the border of South Africa and Namibia. The cluster contains copper, tungsten, and lithium occurrences. Business opportunities exist to support ECRM occurrences within the cluster turning operational.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Processing facilities          | Available data suggest that there are no processing plants in this cluster, merely a single zinc processing plant to the northwest in Namibia. Business opportunities exist to construct processing plants near mining operations. Considerations should be made to available infrastructure and especially the development corridors intersecting the cluster.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Road / shipping infrastructure | Road infrastructure is scarce throughout the cluster. It consists of both primary (trunk) and secondary (national and regional) roadways. Secondary road networks merely support the limited trunk highways, leaving many ECRM occurrences along the international border inaccessible. Two road corridors pass through this cluster: (1) the Tripoli–Windhoek–Cape Town Highway (TAH-3) and (2) the Trans-Oranje Road Corridor. These corridors engulf most of the trunk roads in the cluster, with the exception of the N14 highway spanning between Springbok and Upington in South Africa. The TAH-3 corridor links the cluster directly with the port of Cape Town (South Africa) to the south and indirectly with the ports of Lüderitz Bay and Walvis Bay (Namibia) to the north. There are business opportunities to develop strategic roadways through ECRM-rich areas, especially along the border.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Rail infrastructure            | Rail infrastructure is very limited in the cluster and only found in the Namibian portion, consisting of a segment of the Trans-Oranje development corridor. The Trans-Oranje Railway is operated by the Walvis Bay Corridor Group and links the ports of Walvis Bay and Lüderitz in Namibia with the Northern Cape Province to Johannesburg of South Africa. The rail segment provides a strategic link to the port of Lüderitz, located merely 350 km away from its northern point of intersection with the cluster. Nevertheless, the limited infrastructure provides nearby access to a handful of ECRM occurrences. The TAH-3 road corridor intersects the railway within the corridor, creating an effective road-rail synergy, however, such transit lines may overstrain the port of Lüderitz. The port of Walvis Bay may be used to supplement trade exports, however, the large travel distances and the interaction with export requirements from cluster 14 may hinder its feasibility. As such, considerations may be made into establishing a rail link from the cluster's ECRM-rich zone along the border to existing rail lines in South Africa (Bitterfontein–Cape Town railway along the TAH-3 to the south, or the Sishen–Saldanha railway line to the southeast). This would provide rail access to two additional ports in South Africa and in doing so, heavily relieve the limited road corridors in the region. |

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|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Airports | <p>There are no international airports within this cluster. International airports accessible to the cluster include: (1) Hosea Kutako International Airport and (2) Walvis Bay International Airport in Namibia, and (3) Upington International Airport and (4) Cape Town International Airport in South Africa. All airports are accessible via the region's development corridors, with Upington International Airport being the nearest (approximately 180 km from the cluster's eastern limit). Few regional small-scale airports are found within or proximal to the cluster. Business opportunities exist to establish remote airfields servicing ECRM hotspots.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Ports    | <p>Due to the inland nature of the cluster, no ports are found within its boundaries. Accessible ports include: (1) Lüderitz Bay and (2) Walvis Bay in Namibia, and (3) Saldanha Bay and (4) Cape Town in South Africa. The port of Lüderitz Bay is the most accessible to the cluster and linked directly via the Trans-Oranje Railway. This rail line furthermore links the cluster to the port of Walvis Bay to the north; however, port limitations may exist due to interactions with ECRM activities in cluster 14. The Namibian Ports Authority have announced plans for a US\$ 2.1bn port expansion, including upgrades of the two aforementioned Namibian ports, and in particular, the construction of a second port in Lüderitz. Maritime transportation in South Africa is regarded as the main engine of economic growth. Transnet National Ports Authority (TNPA) manages and governs eight of South Africa's major seaports, including the ports of Saldanha Bay and Cape Town. The Cape Town seaport is the second largest in the country and a hub terminal for cargo to the Far East and South America. The ports of Saldanha Bay and Cape Town in South Africa are accessible directly via the TAH-3 corridor and indirectly via rail external rail infrastructure. Transnet National Ports Authority (TNPA) have announced infrastructure improvement projects at both ports in a bid to support the region's booming shipping demand, however the proposed expansion at Saldanha Bay was recently put on hold.</p> |

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|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Energy        | <p>This cluster has four power stations with generating capacities of 100-1000 MW (2), 10-100 MW (1), and &lt;10 MW (1). They are all on-grid solar power stations, three of which are located in South Africa and one in Namibia. Power distribution infrastructure accommodates for the limited power plants, however, gaps in the grid network persist. Few of the cluster's documented ECRM occurrences currently have direct access to power. In South Africa, approximately 95 % of the electricity is generated by the state-owned and vertically integrated power company, Eskom. To attract renewable energy into the country, an independent power producer program, the Renewable Energy Independent Power Producer Procurement (REIPPP), has been introduced. The country experiences ongoing power outages (load-shedding). To combat this, the development of 8.7 GW worth of (non-hydro) renewable energy is planned to be installed between 2023 and 2032. Namibia's energy supply is inadequate and cannot supply to its rising demand and facilities rarely produce at full capacity. South Africa supplies Namibia with power, however, energy strains have affected its capacity, of which the power purchase agreement expires in 2025. Investment opportunities exist to develop (non-hydro) renewable energy plants in South Africa and green hydrogen, green ammonia, and renewable energies in Namibia, as well as in expanding the grid network to better capture the cluster's ECRM occurrences.</p>                                                                                                                            |
| Communication | <p>Namibia is currently developing its information and communications technology (ICT) at a fast pace and is linked by international satellite services. It has 98 % digital telecommunications infrastructure providing direct dialling to the rest of the world. There is network coverage in most towns, however, the region captured in the cluster remains underdeveloped. Significant mobile service provider are MTC and TN Mobile, delivering up to 4G+ in fragments of the cluster. Significant mobile providers in South Africa are MTN, Cell C, Telekom, and Vodacom, providing network coverage of up to 4G+ in the cluster. The cluster contains terrestrial fibre optic infrastructure spanning both countries. This network links to the Africa Coast to Europe (ACE), SAFE, SAT-3/WASC, South Atlantic Express (SAEx), Equiano, and West African Cable System (WACS) submarine fibre cables via landing stations at Cape Town (South Africa) and Walvis Bay (Namibia). Dark Fibre Africa (DFA) began its ZAR 400m (US\$ 21.3m) fibre network infrastructure expansion project in South Africa in 2023. Namibia's fibre optic network has been extended to the country's borders with Angola, Zambia, Botswana, and South Africa to provide terrestrial access routes and network redundancy. Telecom Namibia and Paratus Namibia have been leading the way in constructing and upgrading Namibia's fibre network. Since 2020, Paratus has invested a total of NA\$ 150m (US\$ 10m) annually in terrestrial fibre infrastructure. Investments may be required to improve mobile network coverage in the cluster, especially in Namibia.</p> |

**Table 102 Infrastructure assessment of Cluster 19: South African Coast (West)**



## 7.20 Cluster 20: North African Coast

|                                                      |                         |
|------------------------------------------------------|-------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 7,078902, Y 35,264967 |
| Area estimated                                       | 408,149 km <sup>2</sup> |
| Predominant ECRM occurrences (prospecting – deposit) | Phosphates, Copper      |
| Country coverage                                     | Algeria, Tunisia        |

### 7.20.1 Location

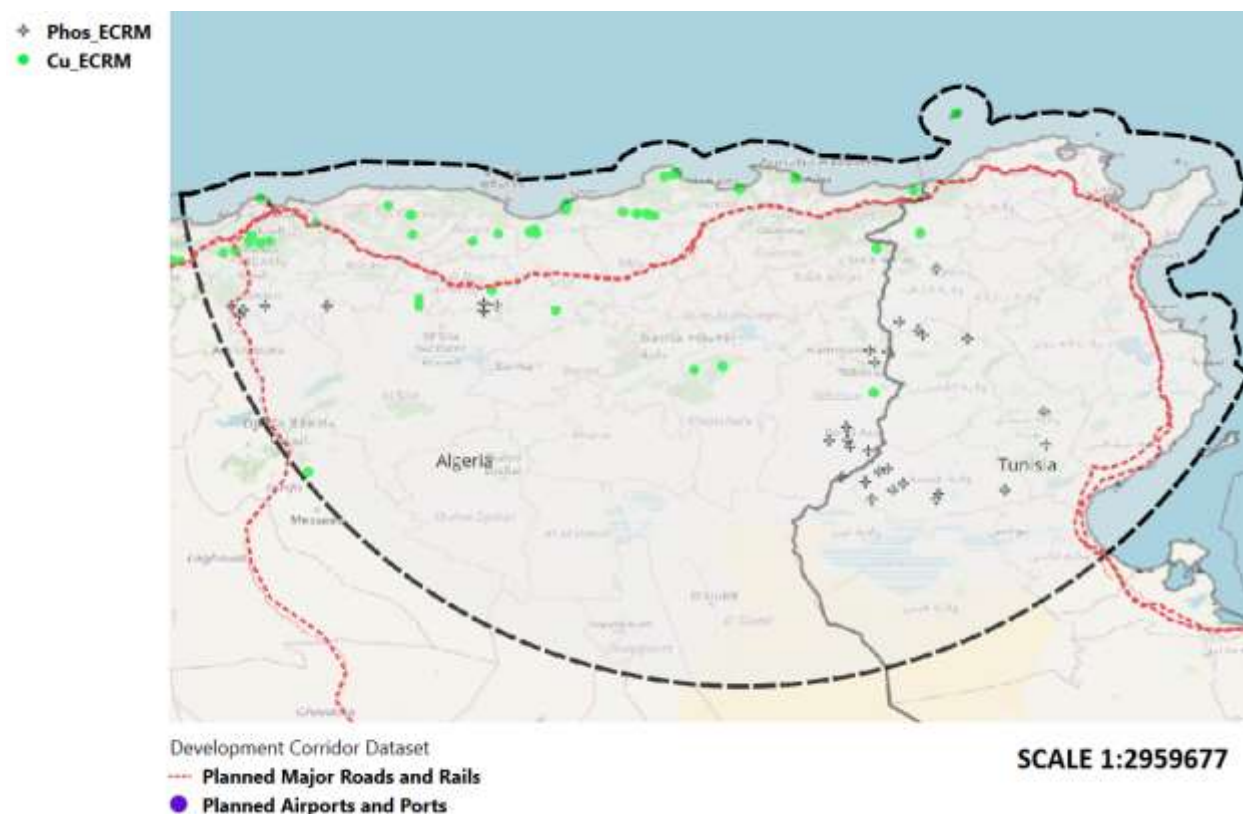


Figure 80 Location of Cluster 20: North African Coast

### 7.20.2 Summary

Cluster 20 covers vast phosphate and subordinated copper occurrences. Especially the phosphate reserves of Algeria with 3.3 % of worldwide availability offers great business potential. Since few years Algeria and Tunisia starting to further exploit their mineral resources to diversify their economy, e.g., Algeria is planning to invest US\$ 7-10bn in an iron ore project. Furthermore, beside ECRM, Tunisia comes into spotlight for green hydrogen supply considering governmental ambitious to generate 30 % of its electricity from photovoltaic systems and wind power plants by as early as 2030. Commissioned by BMZ, GIZ and Ministry of Industry, Mines and Energy lead a project until 2025 called “Green Hydrogen for sustainable growth and a low-carbon economy in Tunisia”. Both countries and Libya approaching a partnership for a strong alliance to ensure regional stability and economic growth. Investments are needed to further exploit ECRM

occurrences and based on this develop or improve domestic processing industry. For this purpose two major development corridors can be used that are connecting Algeria and Tunisia vertically, Trans-Saharan Road Corridor, and horizontally, Trans-Maghreb Highway, with East-African and North-African coastline. To support the adequate rail infrastructure at phosphate and copper occurrences strategic road infrastructure upgrades can be made. Airport and port infrastructure is sufficient for transporting commodities within or out of the countries. Exporting commodities are made via multifunctional ports, whereas investments can be made in process automation to reduce port congestion especially at Algiers port in Algeria. Energy and communication infrastructure is sufficient for meeting current and future demands.

### 7.20.3 Assessment

**Main investment needs:** Mining, processing, road, port.

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism is perceived to be low in Tunisia and Algeria. With respect to the African continent, Tunisia is ranked 29 <sup>th</sup> and Algeria 33 <sup>rd</sup> of the 53-country dataset as of 2022.                                                                                                                                                                                                                                        |
| Artisanal Small-Scale Mining | Tunisia and Algeria are no relevant ASM producer countries for ECRM in Africa. According to the data of DELVE, ASM activities are not mapped in Tunisia and with 0.02 % of the total population, artisanal gold miners are an insignificant group in Algeria.                                                                                                                                                                                                                                                                                                             |
| Mining                       | Algeria and Tunisia have significant mineral resources in iron, lead, gold, zinc, copper and phosphates that are still unexploited due to the focus on oil and gas. ECRM by-products of copper and phosphate occurrences are baryte, antimony, cobalt and nickel. Algeria starts to invest in mineral raw material exploration and exploitation, especially in iron. Tunisia is also looking to diversify its economy by approaching partnerships with Algeria and EU, e.g., hydrogen supply. Investment can be focused on further exploitation of phosphates and copper. |
| Processing facilities        | Processing facilities in Algeria and Tunisia are mainly focused on iron and steel, nitrogen for fertilizer production, cement and salt. Investment can be linked with mining investments to strengthen domestic phosphate and copper processing.                                                                                                                                                                                                                                                                                                                          |

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Road / shipping infrastructure | <p>Road freight transport is the second most-used transport in Algeria and accounts for 86 % of total land freight transport. Two major development corridors are connecting Algeria and Tunisia vertically, Trans-Saharan Road Corridor, and horizontally, Trans-Maghreb Highway, with East-African and North-African coastline. Prospected mineral copper and partially phosphate occurrences are along the Trans-Maghreb Highway. Major phosphate occurrences at the border between both countries are connected via national roads to Trans-Maghreb Highway and the coastline. Investments can be made in Tunisia upgrading strategic national roads into paved highways. Considering the Tunisian “Classified Road Network Development Project II”, the costs are estimated to be US\$ 100,000 per km without maintenance.</p> <p>Shipping infrastructure is less important due to arid conditions.</p> |
| Rail infrastructure            | <p>Rail infrastructure for material transport is connected to phosphate and copper occurrences especially at the border of both countries.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Airports                       | <p>Tunisia has a sufficient number of national and international airports at the coastline and near the phosphate occurrences at the border to Algeria that can be used to relieve the road and rail infrastructure. Same applies to Algeria.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

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|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ports  | <p>The Tunisian port chain is composed of eight commercial ports open to international traffic, Bizerte Menzel Bourguiba (oil), Radès (container traffic), Goulette (passenger and cruise ship traffic), Sousse (traffic of general goods), Sfax-Sid Youssef (multipurpose port), Gabès (industrial port, trafficking in chemicals), Skhira (petrochemical port), and Zarzis (oil and sea salt traffic). With a basin depth of 12 m, the deepest one, Gabès port is capable for receiving ships of all sizes. It has eight docks, and two protective jetties. The port is connected to the rail and highway network, which enables it to support container transport and handling. The port has an equipped storage area of 25,000 m<sup>2</sup>, a covered area of 4,000 m<sup>2</sup> in addition to an available land of 100,000 m<sup>2</sup>. The bulk traffic consists mainly of sulfur and ammonia for import and phosphoric acid and phosphate fertilizer for export. The infrastructure of the port of Gabès allows for the construction of a container terminal and to ensure loading/unloading and transport/handling operations on a regular shipping line, especially as the port has a capacity of 100,000 to 150,000 containers per year.</p> <p>Within the cluster Algeria has four major ports, Annaba (container traffic), Bejaia (petrochemical traffic), Skikda (petrochemical traffic), and Algiers (container traffic). The port of Algiers is Algeria's first multifunctional port that handles almost 60 % of country's container traffic and includes shipping stations, container terminal, oil dock for imports, general cargo docks, grain wharf, and bitumen docks. The draught from the wharves is 6.30 to 10 m. It is connected to the railway and road infrastructure of Trans-Maghreb Highway. The port of Algiers has a total storage area of 282,000 m<sup>2</sup>. This capability allows storage of 120,000 t of goods, while the average monthly volume landed is now 800,000 t. The port of Algiers has put in place 50 % reduction incentives in the tariffs of services provided to Algerian goods for export. It also grants a ten-day free allowance for the stay on terminals for Algerian cargo for export. Operation of the container terminal was contracted to Djazaïr Port World (DPW, a joint subsidiary of the Dubai Port World Group, DP World, and the Algiers Port Company EPAL), officially setup in 2009. Djazaïr Port World (DPW) has a 30-year container terminal concession. According to reports the port of Algiers remains a congested port, where delays are common. Therefore, investments can be made in improving process automation.</p> |
| Energy | <p>Power stations with generation capacities ranging &gt;1000 MW are located at the coastline and near major ports. Copper and phosphate occurrences are well connected with power station ranging between 100-1000 MW, whereas power stations ranging between 10-100 MW distributing energy in remote areas. In Algeria most of the power stations are connected via extra high voltage power lines (220 kV – 400 kV). In both countries Copper and phosphate occurrences are linked to high voltage ranging from 150 kV – 220 kV.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Communication | <p>The submarine fibre cable systems Hannibal and Keltra (owned by Tunisie Telecom) and Se-Me-We (Se-Me-We owner) in Tunisia bringing 6 Tbps international bandwidth capacity to meet current and future medium-term needs. SEA-ME-WE4, ALPAL-2 and Algeria-Spain (Algerie Telecom) and Med (Djezzy) in Algeria bringing up to 140 Gbps sufficient to meet current demands as well. With a penetration rates for fixed and mobile phones of 138.3 % in 2019, Tunisia enjoys one of the highest mobile phone subscriber rates in Africa. Prominent mobile phone providers are Ooredoo, Tunisie Telecom (supported by EU in 2020) and Orange with 98 % national coverage that supply 4G up to 5G in areas with copper and phosphate occurrences. Same applies to Algeria with mobile phone providers Djezzy, Mobilis ATM and Ooredoo as well.</p> |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Table 103 Infrastructure assessment of Cluster 20: North African Coast**

## 7.21 Cluster 21: Madagascar

|                                                      |                                                                                                                          |
|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Coordinates (EPSG:4326 WGS 84)                       | X 47,088040, Y -18,725782                                                                                                |
| Area of Madagascar                                   | 587,041 km <sup>2</sup>                                                                                                  |
| Predominant ECRM occurrences (prospecting – deposit) | Copper, Graphite, Niobium-Tantalum, Lithium, Manganese, Nickel, Tin, Titanium, Tungsten, Fluorite, Phosphates, Aluminium |
| Country coverage                                     | Madagascar                                                                                                               |

### 7.21.1 Location

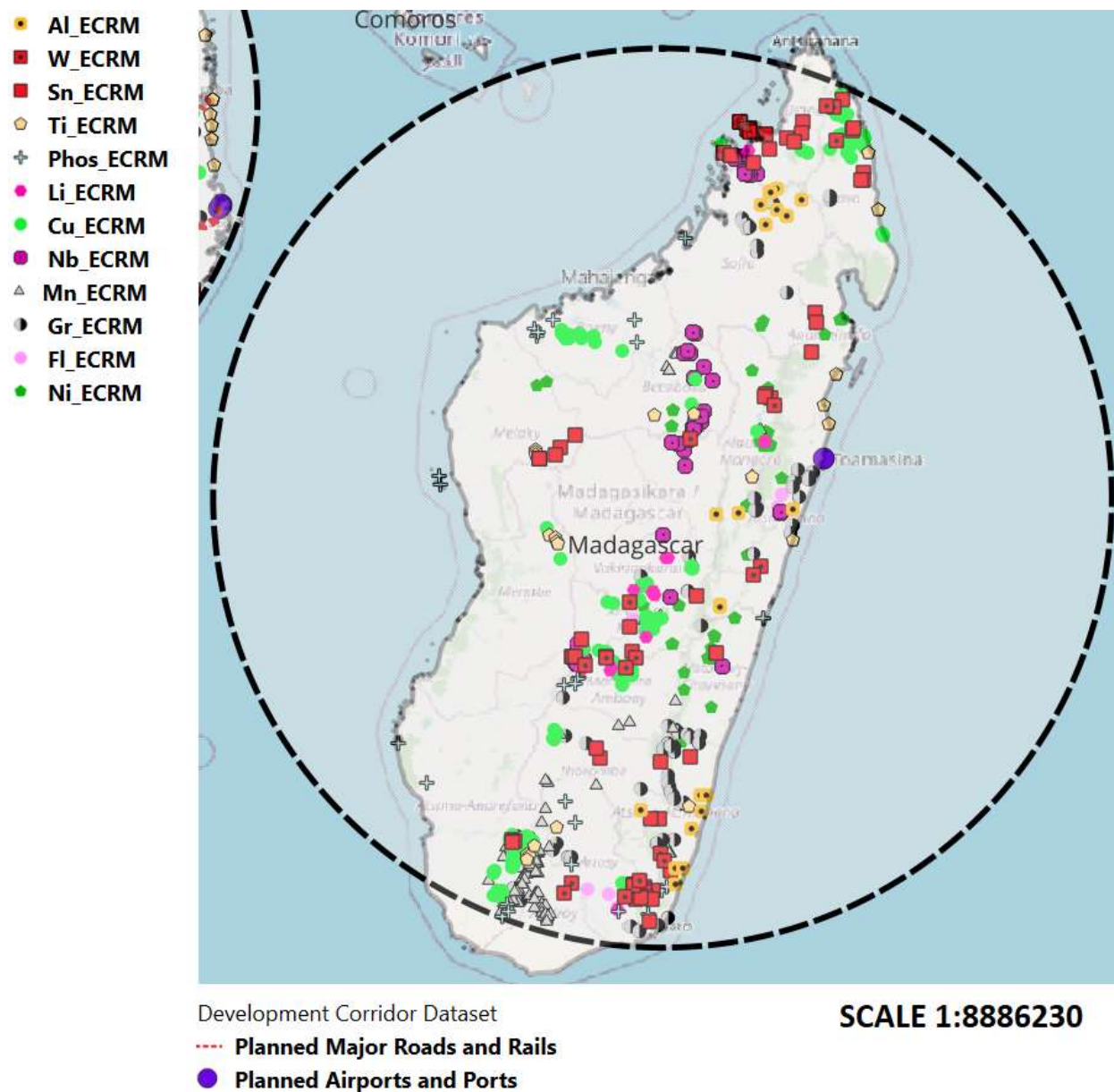


Figure 81 Location of Cluster 21: Madagascar



### 7.21.2 Summary

Please also refer to the AfricaMaVal Project Report - D9.3 – MADAGASCAR case study. Although Madagascar is being assessed in detail within work package 9, it has been selected as an infrastructure cluster to underline its coverage of vast ECRM occurrences. Partnerships with the European Union took place based on political, economic, and trade cooperation, as well as development cooperation, which are likely to be renewed. In comparison to African countries, Madagascar is rated as a political stable country. ASM activities already exploit some ECRMs and plays a crucial role to the nation, providing numerous jobs. The mining and processing sectors in Madagascar are underdeveloped and need investment to exploit the ECRM potential and kick-off production. Modernisation of road infrastructure and the dredging of waterways can be considered on an individual project level. These investments should be harmonised with investments in rail infrastructure, which was abandoned in 1992 and presents a serious alternative to road infrastructure. All roads, waterways, and rails should lead to Madagascar's ports or alternatively to Ivato International Airport, which are capable of transporting ECRM products abroad. In accordance with the National Water and Electricity Company's (JIRAMA) statement that its production capacity is insufficient to meet mining demands, all future mining units should equip themselves or build their own electricity-generating plants, as well as water pumping and treatment facilities. Several energy projects are currently under study or already in development. Nevertheless, investments are needed to support renewable energy production for ECRM projects. Furthermore, investments are needed in relay pylons in remote project areas to improve telecommunication.

### 7.21.3 Assessment

**Main investment needs:** Mining, processing, road, shipping, rail, energy, communication.

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Political stability          | According to the World Bank (2022), the likelihood of political instability and/or politically motivated violence, including terrorism is perceived to be low in Madagascar. With respect to the African continent, Madagascar is ranked 28 <sup>th</sup> of the 53-country dataset as of 2022.                                                                                                                                                                                              |
| Artisanal Small-Scale Mining | Madagascar is a relevant ASM country for ECRM production in Africa. It remains a largely informal activity but is likely the second largest job provider behind agriculture. ECRMs exploited via ASM practices include tantalum-niobium, beryllium, lithium, manganese, rare earths (bastnaesite), strontium (celestine), copper, and natural baryte. Non-ECRMs mined include gold, coloured gemstones, and mica.                                                                            |
| Mining                       | According to the AfricaMaVal Deliverable 9.3, large-scale mines are underdeveloped, processing units are rare, and recycling activities are non-existent, despite the rich mineral potential of the country. ECRM mining activities are in different development stages ranging from geological occurrences to mining concessions, and focus on cobalt, nickel, vanadium, lithium, REEs, graphite, and titanium. Investments are needed to fully exploit the potential of the mining sector. |

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Processing facilities          | <p>According to the AfricaMaVal Deliverable 9.3, the Ambatovy refinery is the biggest refiner in the country, having two units processing nickel and cobalt. Regarding graphite, some are already being exploited on a semi-industrial scale or have been the subject of short-term pilot operations which are now awaiting further investment to ramp up production. Business opportunities exist to support the ramp-up of ECRM mining activities in the country.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Road / shipping infrastructure | <p>According to the AfricaMaVal Deliverable 9.3, Madagascar has 4,598 km of national roads that are all in an advanced state of degradation. The overall penetration of the road network is low. Apart from national roads and a few regional routes, access to certain even inhabited areas is only possible through pedestrian paths or tracks for ox-cart carriages. Several localities in Madagascar are isolated from the rest of the country during the cyclone season. Several road projects are currently underway to improve road infrastructure: (1) the Madagascar Road Network Modernisation Project launched in 2021 with an EU financing of € 235.5m, and (2) the Road Infrastructure Development Project co-financed by the African Development Fund, OPEC Fund for International Development (OFID), OPEC, and the Republic of Madagascar worth US\$ 60.47m. In May 2023, the World Bank announced a tripling of its interventions in road projects until 2024 with the objective of increasing access to rural roads from the current 11.4 % to 30 %. Investments can be considered for improving access roads to individual project sites.</p> <p>Apart from the Canal des Pangalanes, no developments have been made on Madagascar's various waterways. With the perspective of intensive transportation (regular and heavy-duty) and the fact that no appropriate adjustments have been made to their channels, none of Madagascar's rivers are navigable. The Canal des Pangalanes was built in the 20<sup>th</sup> century and stretches 665 km between Toamasina and Farafangana. It can be navigated by shallow-draft boats, subject to repeated dredging. It could be an ideal solution for transporting heavy loads (potentially including ores) to the port of Toamasina. Investments can be considered for dredging waterways linked to individual project sites to make them navigable.</p> |
| Rail infrastructure            | <p>According to the AfricaMaVal Deliverable 9.3, Malagasy railway network consists of four major lines, (1) Antananarivo – Toamasina via Moramanga (TCE - 372 km), (2) Moramanga – Ambatosoratra (MLA - 167 km), (3) Antananarivo – Antsirabe (TA - 171 km), and (4) Fianarantsoa – Manakara (FCE - 163 km). In 1992, railways were abandoned in favour of road transport. In 2002, a 25-year management concession was granted to the company Madarail, which operates the TCE, MLA, and TA lines. The FCE line remains under the management of the Ministry of Transport. The main operation occurs between Toamasina and Antananarivo for the transportation of goods, fuel, and, until the closure of the chromite mines in Andriamena (2019), concentrated chromite to the port of Toamasina. Railways are globally recognised as one of the most cost-effective means of transportation. This was the case in Madagascar before 1992. Investments can be used to reactivate rail infrastructure as serious alternative to road infrastructure.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Airports | <p>Madagascar operates several domestic airports all around the country that transport passengers and air freight. These can be used to transport equipment for individual project sites. The only significant international airport is Ivato International Airport located in the capital city Antananarivo with nine airlines serving 21 destinations in Europe, Asia, and Africa. Material can be transported via rail, road, or air to Ivato before being exported to other countries.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Ports    | <p>According to the AfricaMaVal Deliverable 9.3, Madagascar has 4,828 km of coastline. It has 22 ports, of which only six can accommodate ships of a certain tonnage. These are:</p> <ul style="list-style-type: none"> <li>• Toamasina Port: It is the best-equipped with modern facilities for both transit / customs operations and loading / unloading. 80 % of Madagascar's international maritime traffic is handled by this port, accounting for approximately 1,600,000 t of cargo and 18,900 TEUs. It allows berthing of ships with a draft of 15 m and weighing over 70,000 t. Bulk carriers and general cargo ships can dock there. Its current capacities and logistics are largely the result of its modernisation and expansion initiated in 2018 (65 %, or US\$ 635m via the Japan International Cooperation Agency, and 35 %, or US\$ 228m via the Malagasy Government).</li> <li>• Ehoala Port (since 2009): Built as part of the Fort-Dauphin Ilmenite Project, Ehoala Port resulted from a mutually beneficial solution for the Malagasy government and Rio Tinto QMM. Both parties funded its construction with Rio Tinto QMM contributing US\$ 240m and the Malagasy government US\$ 35m through the Integrated Growth Poles of Anosy (PIC) Project, financed by the World Bank. Ehoala Port serves the public interest and can accommodate ships with a draft of 15.75 m.</li> <li>• Antsiranana Port: With a depth of 8 m at the mooring point.</li> <li>• Toliary Port: Capable of receiving ships with a draft of 7.5 m.</li> <li>• Mahajanga Port: Primarily a transshipment port, it only accommodates ships with a draft of less than 5 m.</li> <li>• Sainte Marie Port (Nosy Boraha): Can only accommodate small vessels weighing less than 250 t and with a shallow draft less than 5 m.</li> </ul> |

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Energy        | <p>According to the AfricaMaVal Deliverable 9.3, "traditional" energies, firewood, and charcoal, represent more than 80 % of the total energy consumed in the country. Supplies of "modern" energies (17 % of consumption) are characterised by a heavy reliance on the oil bill, which weighs heavily on the National Water and Electricity Company (JIRAMA), and therefore on public finances. In 2015, the Malagasy Government launched its New Energy Policy 2015-2030 (NPE 2015-2030), aiming for electrification of at least 70 % of households by 2030 (including 15 % thermal, 0.5 % wind, 5 % solar, and 75 % hydroelectric). According to the World Bank, this objective could only be achieved to the extent of 25 % through the extension of large networks and 75 % through mini-grid solutions (20 %) or individual systems. Hydroelectricity stands at the forefront of renewable energies, with an estimated national hydroelectric potential of 7,800 MW, of which less than 3 % is currently exploited. This aspect is reinforced by the promotion of solar, with an annual estimate of 2,800 h of sunlight, and wind energy potential evaluated at 2,000 MW. Electricity production has been liberalised since 1999, promoting free competition in the production sector and establishing a regulator. However, for multiple reasons (insufficient available power, distance from energy production centres, energy independence, etc.), mining companies ensure their own production with hydroelectric plants or thermal power plants. The National Water and Electricity Company (JIRAMA) has stated that its production capacity is insufficient to meet demand. Therefore, all future mining units should equip themselves or build their own electricity-generating plants, as well as water pumping and treatment facilities. Several energy projects are currently under study or in development. However, investments are needed to support renewable energy production for ECRM projects.</p> |
| Communication | <p>Madagascar is connected to the submarine fibre cable systems EASSy, LION and LION2. According to the AfricaMaVal Deliverable 9.3, the telecommunications sector experienced strong growth of 8.5 % in 2013. Then, a sharp slowdown in 2014, and growth of 4 % from 2015 to 2017. Madagascar hopes to achieve an internet coverage of 90 % of its territory by 2038 to meet the country's objectives in terms of digital transformation. In remote areas isolated from coverage, and subject to conclusive results of a market study by an operator, investments may be required for the installation of relay pylons.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

Table 104 Infrastructure assessment of Cluster 21: Madagascar

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## 8 Conclusions

This report summarised the economic, ESG and infrastructure conditions at 80 mining/value chain projects or regional infrastructure clusters related to critical and strategic raw materials in Africa. This report is not intended as a general scientific reference volume for these projects, since project parameters change quickly and any presented information is expected to become outdated at some point. Rather, through this contribution, the authors wish to encourage follow up discussions on individual projects of interest among stakeholders from the main target group of this report: African project developers, European downstream and financing industries, investors, and policy makers, including the European Commission, EU Member state authorities, as well as their counterparts in Africa.

To this end, the report is organised as a series of project factsheets that can and should be used as individual stand-alone documents outside of this rather large report. The introductory overview shown in each factsheet represents a teaser to encourage follow-up discussions while not aiming to provide a comprehensive due diligence evaluation of a given project – the latter would be a logical next step to be conducted by potential investors or other European stakeholders, in coordination with project developers in Africa. In introducing the concept of and recently launching the first Call on applications for strategic projects, the European Critical Raw Materials Act may present an important supportive framework for any bilateral follow up discussions on developing projects and value chain partnerships between Africa and Europe. The same applies to the EU's strategic raw material partnerships with a growing number of African countries. Readers are therefore encouraged to consider the present report and the projects presented therein in conjunction with these EU policy initiatives as well as similar policies initiated by EU Member states.

## 9 Annex

### 9.1 Projects per country

| Country              | Project                                             | Page Number |
|----------------------|-----------------------------------------------------|-------------|
| <b>Angola</b>        |                                                     |             |
|                      | Longonjo                                            | 217         |
| <b>Botswana</b>      |                                                     |             |
|                      | K.Hill                                              | 199         |
|                      | Motheo (Tshukudu)                                   | 272         |
|                      | Selebi                                              | 128         |
| <b>Burundi</b>       |                                                     |             |
|                      | Musongati                                           | 113         |
| <b>Cameroon</b>      |                                                     |             |
|                      | Minim-Martap                                        | 250         |
|                      | Nkamouna-Mada                                       | 298         |
| <b>Cote d'Ivoire</b> |                                                     |             |
|                      | Samapleu                                            | 121         |
| <b>DR Congo</b>      |                                                     |             |
|                      | Bisie                                               | 174         |
|                      | Manono (tailings)                                   | 417         |
|                      | Mutoshi                                             | 287         |
|                      | Special Economic Zone (SEZ) on battery value chains | 399         |
|                      | Western Foreland                                    | 134         |
| <b>Eritrea</b>       |                                                     |             |
|                      | Yacob Dewar                                         | 140         |
| <b>Gabon</b>         |                                                     |             |
|                      | Maboumine (Mabounié)                                | 93          |
| <b>Ghana</b>         |                                                     |             |
|                      | Ewoyaa                                              | 53          |
| <b>Guinea</b>        |                                                     |             |
|                      | Sangarédi                                           | 313         |
| <b>Guinea-Bissau</b> |                                                     |             |
|                      | Farim                                               | 187         |
| <b>Madagascar</b>    |                                                     |             |
|                      | Ambatovy                                            | 364         |
|                      | Graphmada                                           | 193         |
|                      | Green Giant                                         | 59          |
|                      | Maniry                                              | 244         |
|                      | Millie's Reward                                     | 101         |
|                      | Molo                                                | 256         |
|                      | Toliara                                             | 336         |
| <b>Malawi</b>        |                                                     |             |
|                      | Kangankunde                                         | 74          |
|                      | Kanyika                                             | 205         |
|                      | Kasiya                                              | 80          |

| Country             | Project                                 | Page Number |
|---------------------|-----------------------------------------|-------------|
|                     | Songwe Hill                             | 320         |
| <b>Morocco</b>      |                                         |             |
|                     | Atlas Lion                              | 34          |
| <b>Mozambique</b>   |                                         |             |
|                     | Balama (Syrah)                          | 166         |
|                     | Balama North (Triton)                   | 160         |
|                     | Moma                                    | 265         |
|                     | Monte Muambe                            | 107         |
| <b>Namibia</b>      |                                         |             |
|                     | Eureka                                  | 47          |
|                     | Karibib                                 | 211         |
|                     | Tsumeb                                  | 432         |
|                     | Uis                                     | 343         |
| <b>Rwanda</b>       |                                         |             |
|                     | Musha-Ntunga                            | 280         |
|                     | Nyakabingo                              | 304         |
| <b>South Africa</b> |                                         |             |
|                     | Doornhoek                               | 40          |
|                     | Manganese Metal Co.                     | 387         |
|                     | Phalaborwa                              | 425         |
|                     | Steelpoortdrift                         | 330         |
|                     | Waterberg                               | 351         |
|                     | Zandkopsdrift                           | 146         |
|                     | Zebediela                               | 153         |
| <b>Tanzania</b>     |                                         |             |
|                     | Epanko                                  | 181         |
|                     | Kabanga                                 | 65          |
|                     | Leaching Plant for Artisanal Copper Ore | 380         |
|                     | Lubalisi                                | 87          |
|                     | Mahenge                                 | 230         |
|                     | Nachu                                   | 293         |
| <b>Uganda</b>       |                                         |             |
|                     | Makuutu                                 | 236         |
| <b>Zambia</b>       |                                         |             |
|                     | Konkola                                 | 372         |
|                     | Lumwana                                 | 224         |
|                     | Mopani                                  | 393         |
| <b>Zimbabwe</b>     |                                         |             |
|                     | Kamativi (tailings)                     | 409         |
|                     | Zulu                                    | 357         |

Table 105. List of projects per country

## 9.2 Projects per commodity

Note: the following table identifies only the ECRM main mineral commodities or, in some cases, ECRM co-products associated with a given exploration or mining project. Non-ECRM are not shown. Current or potential ECRM by-products are only shown in the factsheets themselves, not in the table below. The only exception is in case a given project has only non-ECRM as main product; in that case, the ECRM by-products are referenced in the table instead.

| Commodity                  | Project                                             | Page Number |
|----------------------------|-----------------------------------------------------|-------------|
| <b>Aluminium / Bauxite</b> | Minim-Martap                                        | 250         |
|                            | Sangarédi                                           | 313         |
| <b>Cobalt</b>              | Ambatovy                                            | 364         |
|                            | Mutoshi                                             | 287         |
|                            | Nkamouna-Mada                                       | 298         |
|                            | Special Economic Zone (SEZ) on battery value chains | 399         |
| <b>Copper</b>              | Konkola                                             | 372         |
|                            | Leaching Plant for Artisanal Copper Ore             | 380         |
|                            | Lumwana                                             | 224         |
|                            | Mopani                                              | 393         |
|                            | Motheo (Tshukudu)                                   | 199         |
|                            | Mutoshi                                             | 287         |
|                            | Samapleu                                            | 121         |
|                            | Selebi                                              | 128         |
|                            | Western Foreland                                    | 134         |
|                            | Yacob Dewar                                         | 140         |
| <b>Fluorite</b>            | Doornhoek                                           | 40          |
| <b>Gallium</b>             | Tsumeb                                              | 432         |
| <b>Germanium</b>           | Tsumeb                                              | 432         |
| <b>Graphite</b>            | Balama North (Triton)                               | 160         |
|                            | Balama (Syrah)                                      | 166         |
|                            | Epanko                                              | 181         |
|                            | Graphmada                                           | 193         |
|                            | Kasiya                                              | 80          |
|                            | Mahenge                                             | 230         |
|                            | Maniry                                              | 244         |
|                            | Molo                                                | 256         |
|                            | Nachu                                               | 293         |
| <b>Lithium</b>             | Ewoyaa                                              | 53          |

| Commodity                      | Project              | Page Number |
|--------------------------------|----------------------|-------------|
|                                | Kamativi (tailings)  | 409         |
|                                | Karibib              | 211         |
|                                | Manono (tailings)    | 417         |
|                                | Millie's Reward      | 101         |
|                                | Uis                  | 343         |
|                                | Zulu                 | 357         |
| <b>Manganese</b>               |                      |             |
|                                | K.Hill               | 199         |
|                                | Manganese Metal Co.  | 387         |
|                                | Nkamouna-Mada        | 298         |
| <b>Nickel</b>                  |                      |             |
|                                | Ambatovy             | 364         |
|                                | Kabanga              | 65          |
|                                | Lubalisi             | 87          |
|                                | Musongati            | 113         |
|                                | Nkamouna-Mada        | 298         |
|                                | Samapleu             | 121         |
|                                | Selebi               | 128         |
|                                | Zebediela            | 153         |
| <b>Niobium</b>                 |                      |             |
|                                | Kanyika              | 205         |
|                                | Maboumine (Mabounié) | 93          |
| <b>Phosphate rock</b>          |                      |             |
|                                | Farim                | 187         |
| <b>Platinum Group Elements</b> |                      |             |
|                                | Waterberg            | 351         |
|                                | Zebediela            | 153         |
| <b>Rare Earth Elements</b>     |                      |             |
|                                | Eureka               | 47          |
|                                | Kangankunde          | 74          |
|                                | Longonjo             | 217         |
|                                | Maboumine (Mabounié) | 93          |
|                                | Makuutu              | 236         |
|                                | Monte Muambe         | 107         |
|                                | Phalaborwa           | 425         |
|                                | Songwe Hill          | 320         |
|                                | Zandkopsdrift        | 146         |
| <b>Tantalum</b>                |                      |             |
|                                | Musha-Ntungwa        | 280         |
| <b>Tin</b>                     |                      |             |
|                                | Bisie                | 174         |
|                                | Musha-Ntungwa        | 280         |
|                                | Uis                  | 343         |

| Commodity                             | Project         | Page Number |
|---------------------------------------|-----------------|-------------|
| <b>Titanium (Heavy Mineral Sands)</b> | Kasiya          | 80          |
|                                       | Moma            | 265         |
|                                       | Toliara         | 336         |
| <b>Tungsten</b>                       | Nyakabingo      | 304         |
| <b>Vanadium</b>                       | Atlas Lion      | 34          |
|                                       | Green Giant     | 59          |
|                                       | Steelpoortdrift | 330         |

Table 106. List of projects per commodity

### 9.3 Authorship of factsheets

| Factsheet / Task                                                          | Authors                                              |
|---------------------------------------------------------------------------|------------------------------------------------------|
| <b>Exploration, mining and refining/value addition project factsheets</b> |                                                      |
| Ambatovy                                                                  | Jürgen Vasters, Shadrack Phetla                      |
| Atlas Lion                                                                | Malte Stoltnow, Konstantin Kühnel                    |
| Balama (Syrah)                                                            | Sophie Damm, Sean McDonald                           |
| Balama North (Triton)                                                     | Malte Stoltnow, Konstantin Kühnel                    |
| Bisie                                                                     | Malte Stoltnow, Jürgen Vasters                       |
| Copper leaching plant for ASM                                             | Jürgen Vasters                                       |
| Doornhoek                                                                 | Herwig Marbler, Inga Osbahr                          |
| Epanko                                                                    | Malte Stoltnow, Konstantin Kühnel                    |
| Eureka                                                                    | Malte Stoltnow, Konstantin Kühnel                    |
| Ewoyaa                                                                    | Malte Stoltnow, Konstantin Kühnel                    |
| Farim                                                                     | Malte Drobe, Gudrun Franken                          |
| Graphmada                                                                 | Malte Stoltnow                                       |
| Green Giant                                                               | Malte Stoltnow, Konstantin Kühnel                    |
| K.Hill                                                                    | Inga Osbahr                                          |
| Kabanga                                                                   | Jürgen Vasters, Sean McDonald                        |
| Kamativi tailings                                                         | Malte Stoltnow, Konstantin Kühnel, Sean McDonald     |
| Kangankunde                                                               | Martin Erdmann                                       |
| Kanyika                                                                   | Malte Stoltnow, Konstantin Kühnel                    |
| Karibib                                                                   | Malte Stoltnow, Konstantin Kühnel                    |
| Kasiya                                                                    | Malte Stoltnow, Konstantin Kühnel, Shadrack Phetla   |
| Konkola                                                                   | Malte Stoltnow, Malte Drobe, Sibusisiwe Ndlela       |
| Longonjo (Ozango)                                                         | Malte Stoltnow, Konstantin Kühnel, Sibusisiwe Ndlela |
| Lubalisi                                                                  | Inga Osbahr                                          |



|                                                     |                                                      |
|-----------------------------------------------------|------------------------------------------------------|
| Lumwana                                             | Malte Stoltnow, Konstantin Kühnel                    |
| Maboumine (Mabounié)                                | Malte Stoltnow, Konstantin Kühnel, Shadrack Phetla   |
| Mahenge                                             | Malte Stoltnow, Konstantin Kühnel                    |
| Makuutu                                             | Malte Stoltnow, Jürgen Vasters, Sibusisiwe Ndlela    |
| Manganese Metal Co. (MMC)                           | Inga Osbahr                                          |
| Maniry                                              | Malte Stoltnow, Konstantin Kühnel                    |
| Manono (tailings)                                   | Malte Stoltnow, Jürgen Vasters, Sean McDonald        |
| Millie's Reward                                     | Malte Stoltnow                                       |
| Minim-Martap                                        | Malte Stoltnow                                       |
| Molo                                                | Sophie Damm, Lukas Förster                           |
| Moma / Quinga (Nampula)                             | Malte Stoltnow, Konstantin Kühnel                    |
| Monte Muambe                                        | Malte Drobe                                          |
| Mopani                                              | Malte Stoltnow, Malte Drobe                          |
| Motheo (Tshukudu)                                   | Malte Stoltnow, Konstantin Kühnel, Shadrack Phetla   |
| Musha (-Ntunga)                                     | Jürgen Vasters                                       |
| Musongati                                           | Malte Stoltnow, Konstantin Kühnel, Shadrack Phetla   |
| Mutoshi                                             | Philip Schütte, Malte Stoltnow                       |
| Nachu                                               | Malte Stoltnow, Konstantin Kühnel                    |
| Nkamouna-Mada                                       | Malte Stoltnow, Konstantin Kühnel                    |
| Nyakabingo                                          | Jürgen Vasters, Shadrack Phetla                      |
| Phalaborwa                                          | Martin Erdmann                                       |
| Samapleu                                            | Malte Stoltnow, Konstantin Kühnel, Sibusisiwe Ndlela |
| Sangarédi                                           | Jürgen Vasters                                       |
| Selebi-Phikwe                                       | Malte Stoltnow, Konstantin Kühnel                    |
| Songwe Hill                                         | Malte Stoltnow, Martin Erdmann, Sibusisiwe Ndlela    |
| Special Economic Zone (SEZ) on battery value chains | Philip Schütte, Sean McDonald                        |
| Steelpoortdrift "SPD" (Vanadium Resources)          | Sophie Damm                                          |
| Toliara                                             | Malte Stoltnow, Konstantin Kühnel                    |
| Tsumeb                                              | Malte Stoltnow, Malte Drobe, Sibusisiwe Ndlela       |
| Uis                                                 | Malte Drobe, Gudrun Franken, Lukas Förster           |
| Waterberg                                           | Herwig Marbler                                       |
| Western Foreland                                    | Philip Schütte, Malte Stoltnow                       |
| Yacob Dewar (Haykota)                               | Malte Stoltnow, Konstantin Kühnel                    |
| Zandkopsdrift                                       | Malte Stoltnow, Martin Erdmann                       |
| Zebediela                                           | Herwig Marbler                                       |
| Zulu                                                | Malte Stoltnow, Konstantin Kühnel                    |
| <b>Regional infrastructure clusters</b>             |                                                      |
| Cluster 1: West African Coast                       | Lukas Förster                                        |
| Cluster 2: Senegal                                  | Sean McDonald                                        |
| Cluster 3: Morocco                                  | Sean McDonald                                        |
| Cluster 4: Northern and Western Africa (Inland)     | Sean McDonald                                        |
| Cluster 5: Western Africa (Inland)                  | Sean McDonald                                        |

|                                                         |                                                                                                                                                          |
|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cluster 6: Nigeria                                      | Sean McDonald                                                                                                                                            |
| Cluster 7: Western and Central Africa                   | Sean McDonald                                                                                                                                            |
| Cluster 8: Coast of Red Sea                             | Sean McDonald                                                                                                                                            |
| Cluster 9: Central African Coast (West)                 | Sean McDonald                                                                                                                                            |
| Cluster 10: Central and Eastern Africa                  | Sean McDonald                                                                                                                                            |
| Cluster 11: Eastern Africa (North)                      | Lukas Förster                                                                                                                                            |
| Cluster 12: Democratic Republic of the Congo            | Shadrack Phetla                                                                                                                                          |
| Cluster 13: Angola                                      | Shadrack Phetla                                                                                                                                          |
| Cluster 14: Namibia                                     | Shadrack Phetla                                                                                                                                          |
| Cluster 15: Central and Eastern Africa (South)          | Sibusisiwe Ndlela                                                                                                                                        |
| Cluster 16: Eastern Africa (South)                      | Shadrack Phetla                                                                                                                                          |
| Cluster 17: Zimbabwe                                    | Sibusisiwe Ndlela                                                                                                                                        |
| Cluster 18: South Africa (North)                        | Sibusisiwe Ndlela                                                                                                                                        |
| Cluster 19: South African Coast (West)                  | Sibusisiwe Ndlela                                                                                                                                        |
| Cluster 20: North African Coast                         | Lukas Förster                                                                                                                                            |
| Cluster 21: Madagascar                                  | Lukas Förster                                                                                                                                            |
| <b>General AfricaMaVal project responsibilities</b>     |                                                                                                                                                          |
| Work package 7 lead                                     | Philip Schütte                                                                                                                                           |
| Task 7.1 lead (project selection)                       | Philip Schütte                                                                                                                                           |
| Task 7.2 lead (factsheets)                              | Malte Drobe, Gudrun Franken                                                                                                                              |
| Task 7.3 lead (infrastructure)                          | Lukas Förster                                                                                                                                            |
| Factsheet review - ESG                                  | Gudrun Franken                                                                                                                                           |
| Factsheet review - economics & geology                  | Malte Drobe                                                                                                                                              |
| Factsheet review - infrastructure (projects & clusters) | Lukas Förster, Nikolaos Christou, Sean McDonald                                                                                                          |
| Task 7.1 contributing authors                           | Philip Schütte                                                                                                                                           |
| Task 7.2 contributing authors                           | Malte Stoltnow, Konstantin Kühnel, Malte Drobe, Gudrun Franken, Jürgen Vasters, Philip Schütte, Inga Osbahr, Sophie Damm, Herwig Marbler, Martin Erdmann |
| Task 7.3 contributing authors                           | Sean McDonald, Lukas Förster, Sibusisiwe Ndlela, Shadrack Phetla                                                                                         |

**Table 107. Authorship & general responsibilities**