Horizon Europe Framework Programme (HORIZON)

D9.3 – Zimbabwe Case study

WP9 - Task 9.4

Date [06/12/2023]

M. Meck[1] G. Jemwa[2] G Chigumira [3] T. Fullgraf[4] F. Mugyenyi[5]

[1]*University of Zimbabwe*

[2]*Native Geosciences Consultancy Services,*

[3] *Zimbabwe Economic Policy Analysis and Research Unit*

[4]*BRGM*

[5]*MADI*

Disclaimer

The content of this deliverable reflects only the author's view. The European Commission is not responsible for any use that may be made of the information it contains.

Document information

Grant Agreement / Proposal ID	101057832
Project Title	EU-**Africa** Partnership on Raw **Ma**terial **Val**ue chains
Project Acronym	AfricaMaVal
Project Coordinator	Guillaneau Jean-Claude (jc.guillaneau@brgm.fr) - BRGM
Project starting date (duration)	1st June 2022 (42 months)
Related Work Package	WP9
Related Task(s)	Task 9.4
Lead Organisation	BRGM
Contributing Partner(s)	LNEG
Due Date	January 2024
Submission Date	January 2024
Dissemination level	

History

Date	Version	Submitted by	Reviewed by	Comments
26/10/2023	Draft	MADI – M. L. Meck	BRGM – Y. Callec	Typos, structure & content to review
08/12/2023	V1	MADI – M. L. Meck	BRGM – C. Zammit	structure & content to review + WP5-6-7 to add
29/01/2024	V2	MADI – M. L. Meck	BRGM – C. Zammit	WP5-to add + table processing units + structure & content
31/01/2024	V3	MADI – M. L. Meck	BRGM – C. Zammit	Insertion of missing information
31/01/2024	FINAL	BRGM – C. Zammit	BRGM. L. Bailly	

Funded by
the European Union

Acknowledgements

This work was done for an EU-funded horizon project on Critical Raw Materials (CRMs) entitled “Building EU-Africa Partnerships on Sustainable Raw Materials Value Chain”, acronymed “AfricaMaVal”.

The consultant acknowledges the input and support provided by all stakeholders in the minerals value chain sectors. Appreciation goes to MADI for administering the project as well as monitoring, evaluating and verifying the project. A special mention goes to the following:

- MADI Technical team Mr. Sabukwigura Jean Baptiste, Ms Angela Mulenga and Dr Frank Dixon Mugyenyi for coordinating the project and giving directions.
- Ministry of mines and mining development officials for opening up of the project, availing staff of the ministry to work with, guidance on areas for prioritization and reviewing findings of the research.
- The directorate of Geological Survey of Zimbabwe through the Director Mr. Forbes Mugumbate for providing data and information. A special thanks goes to Mugandani Ernest, Munhapa Milton, Shawarira Lloyd for assisting with data collection.
- Zimbabwe National Statistics Agency - ZimStats staff Tarisai Satumba, Kuda Chiguma and Matiwonesa Phiri for providing production statistics.
- Mineral marketing Cooperation of Zimbabwe (MMCZ) staff Dr Nomsa Jane Moyo, Mr. Gumisai Nenzou and Namatai Nyoka for assisting with marketing statistics.
- Thomas Fullgraf (BRGM) for guidance on minerals of interest for predictivity mapping.
- Mining houses for allowing us to access their properties during the course of the work.
- The University of Zimbabwe - Faculty of Science for their support.
- Geology students Kudzai Mutembedza and Terrence Musekiwa for assisting with ECRMs data capture plotting and digitizing the data.
- The Consultancy team comprising of Mr. Gilbert Jemwa, Dr Chigumira and Thomas Fullgraf for implementing the project.

The team leader (Dr Maideyi Meck) bears full responsibility for all the errors and omissions.

Funded by
the European Union

Table of Contents

Funded by
the European Union

List of Figures

Funded by
the European Union

List of Tables

Abbreviations and Acronyms

Funded by
the European Union

Acronym	Description
AMV	African Mining Vision
AMREC	African Mineral and Energy Resources Classification and Management System
AOI	areas of interest
APP	Approved Processing Plant
APT	Additional Profits Tax
ASM	Artisanal and Small-Scale Mining
BRGM	Bureau de Recherches Géologiques et Minières
CRMs	Critical Raw Materials
COM	Chamber of mines of Zimbabwe (COMZ)
DBA	disc-based association
DMS	dense media separation
ECRMs	Extended Critical Raw Materials
EMA	Environmental Management Agency
EPA	Economic Partnership Agreement
EPO	Exclusive Prospecting Orders
ESG	Environmental, Social and Governance
EU	European Union
EV	Electric vehicles
FRP	Fidelity Refiners and Printers
GDP	Gross Domestic Product

Funded by
the European Union

GeoSurv	Government Geological Survey
GoZ	Government of Zimbabwe
IEA	International Energy Agency
IFS	International Financial Institutions
IMR	Institute of Mining Research
IISD	International Institute for Sustainable Development
LCT	Lithium-cesium-tantalum
LME	London Metals Exchange
LSZ	Lower Sulphide Zone
MAA	Minerals Audit Agency
MADI	Minerals Africa Development institutions
MMCZ	Minerals Marketing Corporation of Zimbabwe
MMMD	Ministry of mines and Mining Development
MPM	Mineral Potential Mapping
MSZ	Main Sulphide Zone
NDS	National Development Strategy
PGMs	Platinum Group Elements
PAMUST	Pan African Minerals University of Science and Technology
PMD	Provincial Mining Director
RBZ	Reserve Bank of Zimbabwe
RDCs	Rural District Councils
RF	Random Forest
ROM	Run of Mine

Funded by
the European Union

SDGs	Sustainable Development Goals
SI	Statutory Instrument
SML	Special Mining Lease
SOTER	Soil and Terrain (soil map)
SRTM	Shuttle Radar Topography Mission
TSP	Transitional Stabilization Programme
UNCCD	United Nations Convention to Combat Desertification
US	United States of America
USGS	United States Geological Survey
UZ	University of Zimbabwe
WP	Work package
WPIC	World Platinum Investment Council
ZEPARU	Zimbabwe Economic Policy and Research Unit
ZEU	Zimbabwe Economic Update
ZIDA	Zimbabwe Investment Development Agency
ZIMRA	Zimbabwe Revenue Authority
ZMDC	Zimbabwe Mining Development Corporation
ZSE	Zimbabwe Stock Exchange

Funded by
the European Union

Executive Summary

Critical minerals are essential for the development of various industries, such as renewable energy, electronics, defense, and health. Zimbabwe has a rich endowment of critical minerals that includes lithium, platinum, cobalt, and rare earth elements, but faces challenges in developing its full potential. The value chain of critical minerals in Zimbabwe consists of upstream activities in the form of exploration, mining, and beneficiation; and downstream activities in the form of processing, manufacturing, and recycling.

The objective of this work was to describe the state of play of critical minerals value chain in Zimbabwe as well as provide an overview of the mineral potential of the country, investment financing prospects and fiscal regulation, environmental and social framework for the whole value chain, and to assess how the AfricaMaval project could potentially improve these issues. The study used literature review, data collection, gap analysis, risk assessment and field visits to address these objectives. Zimbabwe is a significant producer and exporter of critical minerals such as lithium, nickel and manganese, which are essential for the global transition to low-carbon energy.

Using Mineral potential mapping (a technique that uses geospatial data and models to identify and rank areas that have a high potential to host mineral deposits), five critical minerals (Be, Li, Ni, Ta, and W)'s geological settings, occurrences, and favourable factors are described in this report.

Though small scale and medium scale mining is observed throughout the country, the upstream sector is dominated by large-scale mining companies, while the downstream sector is largely underdeveloped and dependent on imports. Zimbabwe's minerals ore processing and refining capacities is still low but there is potential for growth. However, the country faces several challenges and opportunities in developing its critical minerals value chain. The work identified the main bottlenecks and challenges that hinder the development of the value chain, as infrastructure, skills, finance, governance, and environmental and social issues.

This report provides an overview of the investment financing prospects and fiscal regulation of the mining sector in Zimbabwe, as well as the policy and legal framework that governs the sector. The report also discusses the opportunities and incentives for investors, as well as the risks and uncertainties that affect the sector's performance. Sustainability and governance issues of the Zimbabwean critical minerals is assessed in this report. Opportunities for the mining sector in Zimbabwe are evaluated.

Keywords

ECRM, Mineral potential, Ore processing, Refining capacities, Recycling units, Value chain, Primary raw material, Secondary raw material, Bottlenecks, Finance, Investment, Sustainability, ESG, Land-use, Taxation, Mining regulation, Mining policies, Child labour, Responsible extraction, Zimbabwe, Beryllium, Fluorspar , Lithium, Magnesium, Manganese, Niobium, PGMs, Antimony Tantalum, Tungsten

Funded by
the European Union

Wording

Mineral prospectivity: “Mineral potential mapping is concerned with quantifying and mapping the likelihood that mineral deposits are present in a study area. It is synonymous to mineral prospectivity mapping, which is concerned with quantifying and mapping the likelihood that mineral deposits may be found by exploration in a study area.”

Funded by
the European Union

1. Extended Critical Raw Materials (ECRM) supply potential of Zimbabwe

AfricaMaVal is focusing on the minerals and metals present in the fourth list of CRMs for the EU as well as on Copper (Cu), Nickel (Ni), Tin (Sn) and Manganese (Mn) that are particularly pertinent considering Africa's geological potential and their critical status in the digital and energy twin transitions. Zimbabwe is host to most of the ECRM.

1.1. Inventory of the ECRM

At the time of this report the inventory of documented ECRMs in Zimbabwe as of December 2023 is as follows: lithium (37), graphite (9), antimony (28), barite (8), beryllium (76), bismuth (5), cobalt (5), coking coal (24), fluorspar (9), PGE (11), phosphate rock (3) , silicon metal (13), tantalum (37), tungsten (6), vanadium (3), bauxite (4), copper (70), nickel (14), manganese (8).

1.1.1 Geological setting

The geology of Zimbabwe is mainly characterized by the Zimbabwe Craton, a core of Archean basement composed of granitoids, schist and gneisses, which is surrounded by Proterozoic and Phanerozoic sedimentary basins and mobile belts. The craton also incorporates greenstone belts comprising mafic, ultramafic and felsic volcanics, which are associated with epiclastic sediments and iron formations. These greenstone belts host most of the country's mineral resources, including gold, platinum group elements, nickel, copper, iron ore and coal. The most prominent geological feature of Zimbabwe is the Great Dyke, an elongate ultramafic/mafic igneous complex that runs for more than 500 km along a SSW/NNE oriented graben. The Great Dyke consists of peridotites, pyroxenites, norites and bands of chromitite, and contains the main sulfide zone, the principal platinum group element-bearing horizon in the country. The geology of Zimbabwe reflects a long and complex history of tectonic, magmatic, metamorphic and sedimentary processes that span from the Archean to the present day. Figure 1 shows the geological map of Zimbabwe

Funded by
the European Union

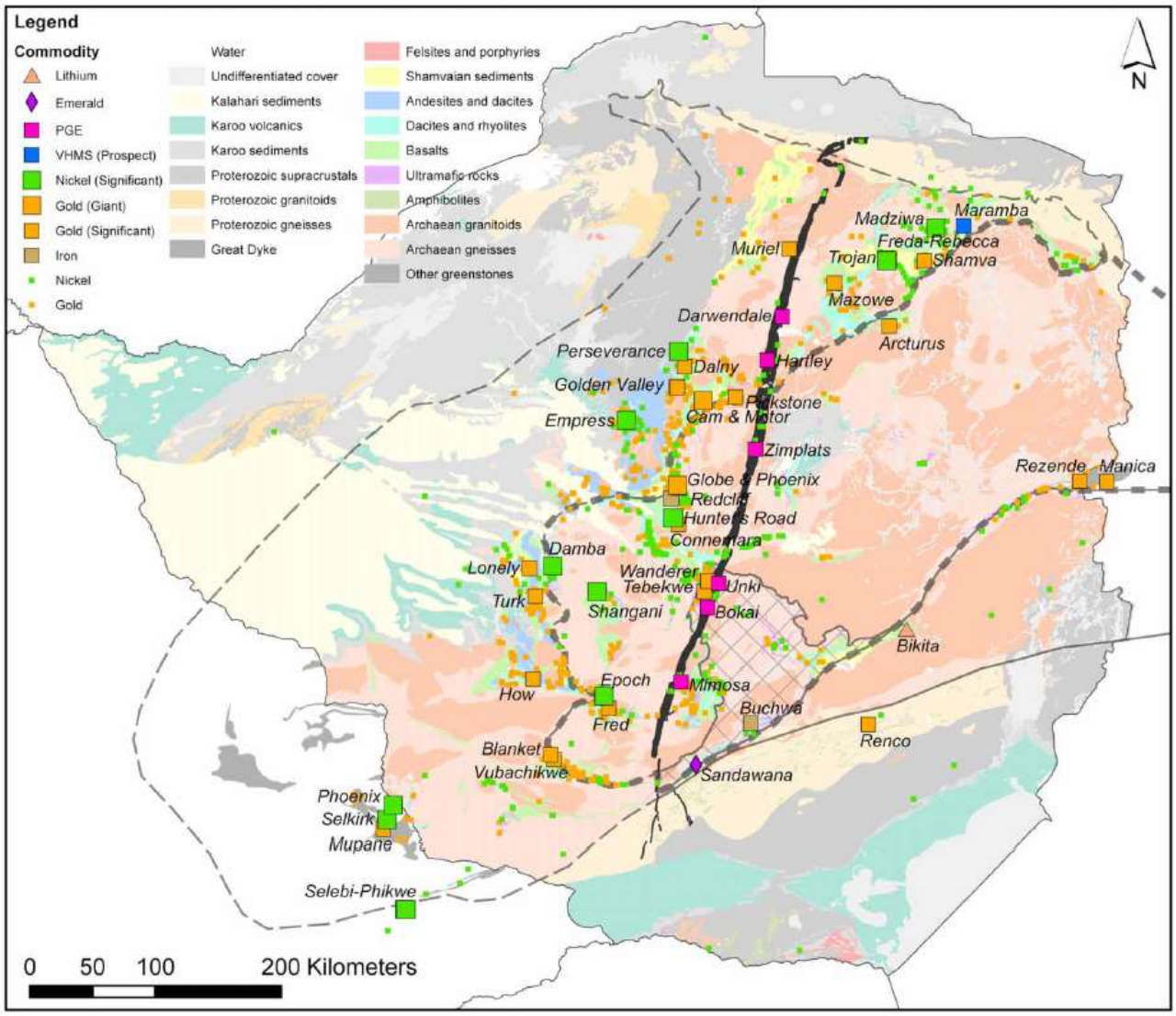


Figure 1 Simplified Geological map of Zimbabwe[1]

1.1.2 Known Ore deposits and occurrences

Among the mineral resources of Zimbabwe are critical raw materials (CRMs), which are essential for the development of high-tech industries and green technologies. CRMs include rare earth elements (REEs), platinum group elements (PGEs), lithium, cobalt, tantalum, niobium, and graphite. Zimbabwe has significant potential for the production of these CRMs, as they are associated with different geological settings and mineralization styles.

The main geological domains that host CRMs in Zimbabwe are the Archean Zimbabwe Craton, the Proterozoic Magondi Belt, the Karoo Basin, and the Limpopo Belt. The craton also hosts several REE

[1] Exploring our current understanding of the geological evolution and mineral endowment of the Zimbabwe Craton. 2021

Funded by
the European Union

deposits in carbonatites and pegmatites, as well as graphite deposits in metamorphic rocks. The Magondi Belt hosts lithium deposits in pegmatites and spodumene-bearing granites, as well as tantalum and niobium deposits in rare-metal granites and pegmatites. The Karoo hosts coal deposits that are potential sources of coal-bed methane and coal-to-liquids. The basin also hosts lithium deposits in lacustrine sediments and claystones. The Limpopo hosts PGEs and chromite deposits in layered mafic intrusions, as well as REEs in carbonatites.

Zimbabwe hosts, after South Africa, the second largest known platinum world reserves, in the Main Sulphide Zone on the Great Dyke. The Great Dyke consists of four ultramafic/mafic complexes, with from north to south, Musengezi, Hartley, Selukwe and Wedza. The Hartley Complex is the largest and contains about 80 % of Zimbabwe's total PGM resources. With at least 20 % of mineral exports revenue, platinum is among the country's largest foreign currency earners.

Zimbabwe hosts the largest coal reserves in the Lower Karoo rocks of the mid-Zambezi Basin and the Save-Limpopo basin. Most of the country's coal deposits are located in the north-western parts of the country in Matabeleland North where all the mines are concentrated. Coal is also a source and reservoir for methane gaz occurrence. It mainly occurs in the Middle Zambezi Basin (e.g. Lupine tenement) and in the Save Limpopo Basin (e.g. Save Runde district).

Nickel is produced at several mines located on the greenstone belt and more than 30 deposits were identified. Nickel sulphides are hosted by a variety of komatiite and mafic rocks. BNC (Bindura Nickel Corporation Ltd is the largest nickel producer with the main operation being at Trojan Mine in Bindura (Mashonaland Central Province). BNC also owns the Shangani deposit in the central part of Zimbabwe. Other nickel deposits are hosted by the Great Dyke where companies such as Zimplats is involved in nickel mining at Bimha Mine.

Graphite occurrences are mainly located in mid-Precambrian, early Proterozoic sedimentary formations within the Hurungwe and Makonde districts, and to Precambrian rocks in the Hwange district. The Lynx graphite mine was the only operating mine in the country. It is located near Karoi, in the Hurungwe district. Several other deposits of the same district have produced small amounts of graphite (Graphite King mine, Juma, Silaka, Kaswaya and Zororo claims).

Eleven occurrences of alkaline rocks associated or not with carbonatites have been identified in Zimbabwe. Several of these occurrences were investigated for their phosphate potential but their REE potential remains unknown. Several exploration projects were conducted on these rocks, the results of which remain unknown.

Pegmatites in Zimbabwe have been noted to be enriched in elements such as Li, Cs, Ta, Sn, and Rb. The Zimbabwean pegmatites are mainly hosted in metamorphosed supracrustal rocks of the Archaean Zimbabwe Craton where they are believed to have formed during the Meso- to Neoarchean period. The pegmatites can be divided into two groups: an early pegmatite suite that is genetically related to the granitoids and a late pegmatite suite that is almost 1000 million years younger and formed by partial melting of metasediments during the assembly of Rodinia. The late pegmatites include the Bikita

Funded by
the European Union

pegmatite, which is one of the largest and the only exploited lithium deposits in Africa, and the Kamativi pegmatite, which was previously mined for tin and is now being investigated for lithium.

The main types of Zimbabwean pegmatites are:

- Lithium-cesium-tantalum (LCT) pegmatites, which contain spodumene, lepidolite, pollucite and tantalite as the main ore minerals. These pegmatites are the most economically important, as they account for most of the lithium production in Zimbabwe. Examples of LCT pegmatites include the Bikita pegmatite and the Kamativi pegmatite.
- Petalite pegmatites, which contain petalite as the main lithium-bearing mineral. These pegmatites are less common and less explored than LCT pegmatites, but they may have significant lithium resources. Examples of petalite pegmatites include the Zulu pegmatite and the Sandawana pegmatite, which also contains emerald and beryl.
- Beryl-columbite-phosphate (BCP) pegmatites, which contain beryl, columbite and phosphate minerals as the main ore minerals. These pegmatites are not very important for lithium production, but they may have potential for tantalum, niobium and beryllium extraction. Examples of BCP pegmatites include the Mwami pegmatite and the Mutoko pegmatite.

The spatial and temporal relationships of Zimbabwean pegmatites are not well understood, but they are generally related to regional tectonic events and magmatic processes that affected the Zimbabwe Craton during the Archean. The economic potential of Zimbabwean pegmatites depends on several factors, such as their size, grade, mineralogy, accessibility and market demand.

1.2. Prospectivity and mineral high potential mapping

Zimbabwe's main commodities are gold, nickel, iron ore, lithium, tantalite, tin, wolframite, precious stones, diamonds, platinum group metals, chromium, coal and uranium. The distribution of these raw materials is linked to specific geological features, especially the greenstone belts found in the Zimbabwe craton (Au, Ni), the Great Dyke (Cr, PGM), pegmatite swarms (lithium, tantalite, tin), and the Karoo basins (coal). In addition, the BRGM database indicates the country's potential for manganese, copper, antimony, bauxite and al-silicates, amongst other ECRM’s as well as a wealth of industrial minerals and ornamental stones. Zimbabwe currently has operational mines for lithium (4), nickel (3), PGM (10) and wolframite (1).

Funded by
the European Union

Zimbabwe (1268 occ.)			Archean	Paleoproterozoic			Neoproterozoic	Paleozoic-Mesozoic	Cenozoic	
Subst. AfricaMaVal	Element	No occ	Zimbabwe Craton (754)	Great Dyke (62)	Limpopo Belt (3)	Magondi Belt (312)	Zambezi Belt (13)	Karoo Basin (59)		Sum
Bauxite	Al	4	*					*		0
Beryllium	Be	237	1			2	*			3
Bismuth	Bi	7	0.5							0.5
Borate	B									0
Baryte	Ba	10	*							0
Cobalt	Co	11	1	*						1
Coal	C	37						2		2
Copper	Cu	117	1	1	*	1		0.5		3.5
Fluorine	F	10				0.5		*		0.5
Gallium	Ga (Al, Zn)									0
Germanium	Ge (Zn)									0
Graphite	C	9				1				1
Hafnium	Hf (Zr, HM)									0
HM	Heavy Minerals	47							2	2
Indium	In (Zn)									0
Lithium	Li	43	1			1				2
Magnesium	Mg	10	1		*			*		1
Manganese	Mn	12	1					1		2
Niobium	Nb	8	*			*				0
Nickel	Ni	30	1	2						3
Phosphorus	P	4	*							0
Platinum Group Metals	Pt, Pd, Rd	50	2	2						4
REE non-diff	REE									0
HREE	HREE									0
LREE	LREE									0
Antimony	Sb	35	1							1
Scandium	Sc									0
Siliciumoxide	SiO2									0
Tin	Sn	76	1			1				2
Strontium	Sr									0
Tantalum	Ta	142	2			1	*			3
Titanium	Ti									0
Vanadium	V	3								0
Tungsten	W	355	2	*	0.5	1	*	0.5		4
Zinc	Zn	11	0.5			2				2.5
		Sum	16	5	0.5	10.5	0	4	2	

0.5	Minor presence
1	Presence
2	Major presence
*	Potential

Table 1 Overview of known mineral occurrences in Zimbabwe and their geological environment[2]

[2] Based on SIG-Afrique of BRGM

Funded by
the European Union

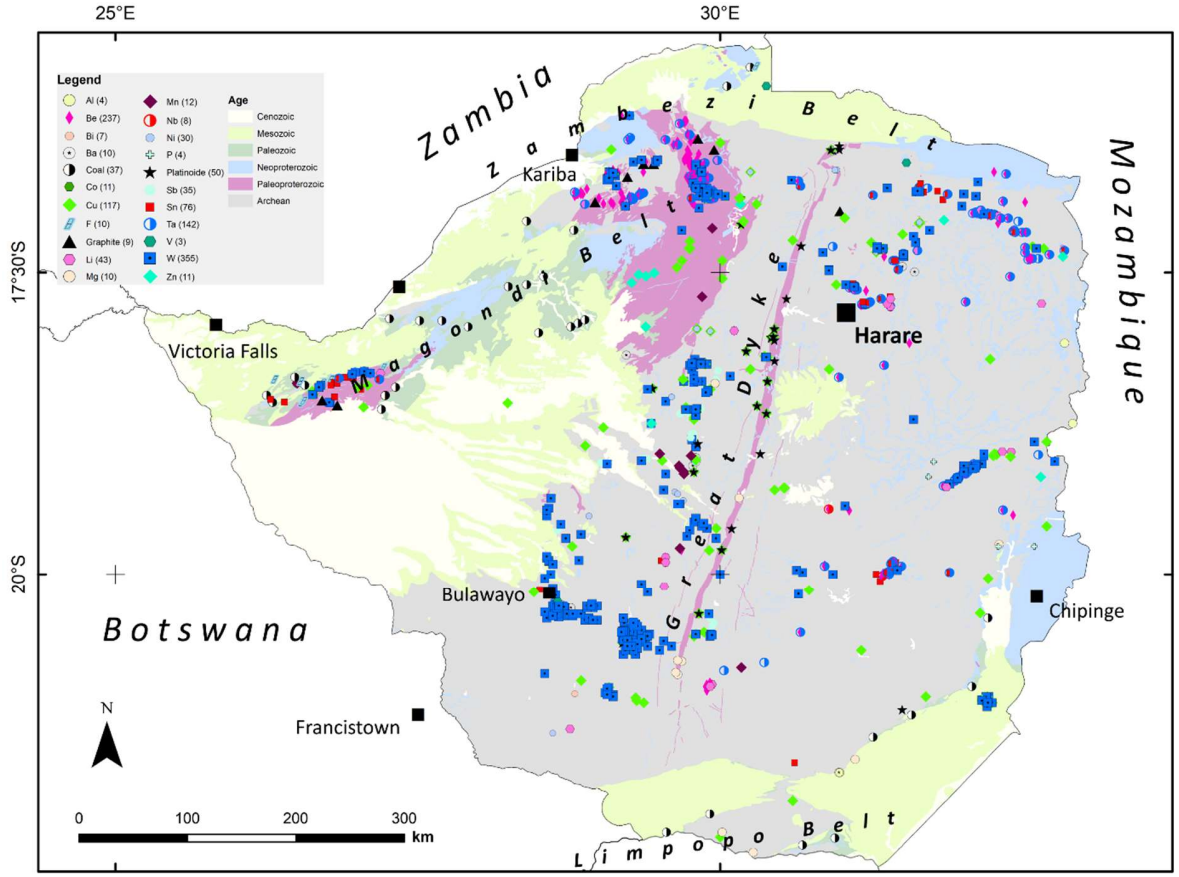


Figure 2 ECRM occurrences recorded in the SIG-Afrique of BRGM

1.2.1 Selection of the ECRM for mineral prospectivity

Among the 35 ECRMs present in Zimbabwe, five were selected for the Mineral Potential Mapping task (MPM) in order to demonstrate the principle of the method: **Be, Li**, **Ni**, **Ta** and **W**. A special study was done on lateritic nickel deposits, which have been identified in northern Zimbabwe. The lack of geoscientific data (e.g. aerial and ground geophysics, satellite data, and soil / stream geochemistry) and the relatively low resolution of the geological map used for this study (1:2M) implies only limited interest of the weakly constrained mineral potential maps for exploration. There was no use to illustrate this for the whole range of ECRM's.

The MPM was performed using the disc-based association (DBA) grid method coupled with Random Forest (RF) method (*Vella, 2022*); the algorithm applying these principles has been labelled "FAMME" by the author. The method is based on the analysis of the local spatial associations of geological variables and features of various natures to describe the relationships between the predictors and the mineralization. This allows the identification of geological environments in the study area around each node of the DBA grid, and the integration of both quantitative and non-quantitative spatial data, such as geophysical anomaly maps and location of geological map units, respectively. In a second step, RF classification is used to perform a generalization of complex geological environments and features and evaluate their likelihood to host potential mineralization occurrences by giving a score between 0 (low potential) and 1 (high potential).

Funded by
the European Union

The data for the MPM of Zimbabwe comprised the following:

- SIG-Afrique mineral resources database – BRGM
- Lateritic Nickel occurrences presented by Prendergast (2016)
- SIG-Afrique 1:2,000,000 geology - BRGM
- SIG-Afrique 1:2,000,000 structural data (faults, thrusts) – BRGM
- UNCCD 1:500k Soil and Terrain (SOTER) – soil map of southern Africa
- SRTM (Shuttle Radar Topography Mission)
- Slope

The DBA grid for predictive modelling is mainly defined by **five parameters**:

- Size of cell – d;
- Buffer for lithologies – R;
- Buffer for mineral occurrences – R1. It can be null (= false), in this case the search radius will be restricted to the cell size (d)
- Buffer for faults – R2. It can be null (= false), in this case the search radius will be restricted to the cell size; it can also take into account the distance of the cell to the neighbouring faults (distance)
- Buffer for soils – R3. It can be null (= false), in this case the search radius will be restricted to the cell size

In order to maximize the grid resolution while minimizing overlaps and cells with only one lithology, the parameters of DBA grid for the four selected commodities in individual areas of interest (AOI) used in this study are as indicated in Table 2.

Parameter/ECRM	Be	Li	Ni_all	Ni_lat.	Ta	W
d [m]	2250	2250	2250	1000	2250	2250
R [m]	9000	9000	9000	5000	9000	9000
R/d	4	4	4	5	4	4
Total cells	123590	123590	123590	88166	123590	123590
R_1 [m]	2000	2000	2000	1000	2000	2000
R_2 [m]	1000	1000	1000	no	1000	750
R_3 [m]	no	no	no	false	no	no
srtm	no	no	no	yes	no	no
slope	no	no	no	yes	no	no
merged ultramafic rocks (UB)	no	no	false	false	no	no

Table 2 The applied parameters for the MPM's of Zimbabwe[3]

1.2.2 Mineral high potential areas

Predictive mapping of critical raw materials in Zimbabwe can help to improve the exploration efficiency, reduce the environmental footprint, and enhance the social acceptance of mining activities. Predictive mapping is a technique that uses geospatial data and models to identify and rank areas that have a high potential to host mineral deposits. The ECRMs in Zimbabwe have different geological settings and require different exploration methods and models. The PGMs are associated with layered mafic intrusions, lithium is found in pegmatites, cobalt is linked to copper deposits, tantalum occurs in carbonatites, and REEs are hosted by alkaline rocks. Predictive mapping of these materials can use various types of data, such as geological maps, geochemical surveys, geophysical surveys, remote sensing images, and mineral occurrence databases. By applying spatial analysis techniques, such as weights of evidence, fuzzy logic, or

[3] "yes/nota" = data used/not used for the analysis

Funded by
the European Union

machine learning, these data can be integrated and processed to produce prospectivity maps that show the spatial distribution of mineral potential. These maps can then be used to guide further exploration activities and inform decision making on resource management and policy.

The data for the production of the MPM comprised the 1:2M scale geological map and structural data of Zimbabwe, the UN-CCD 500k SOTER soil map of southern Africa, the SRTM and the slope.

Areas of high mineral potential for the ECRM's Be, Li, Ni, Ta and W

Six mineral potential maps were produced for the five selected ECRM's (**Be**, **Li**, **Ni**, **Ta**, and **W)**. The results of the DBA-RF (TN, FN, FP, TP = confusion matrix) together with the critical parameter for the assessment of the model are shown in Table 3.

	TN	FN	FP	TP	TPR	FPR	PPA [%]	Prec. [%]	Acc. [%]	J-score	Thresh.
Beryllium	72099	18	5735	374	0.95	0.07	7.8	6.12	92.6	0.88	0.50
Lithium	74000	2	4139	89	0.98	0.05	5.4	2.11	94.7	0.93	0.52
Nickel_all	74763	5	3384	74	0.94	0.04	4.4	2.14	95.7	0.89	0.51
Nickel_lat.	62471	0	113	28	1.00	0.00	0.2	19.86	99.8	1.00	0.63
Tantalum	70780	16	7171	259	0.94	0.09	9.5	3.49	90.8	0.85	0.52
Tungsten	69479	14	8187	546	0.98	0.11	11.2	6.25	89.5	0.87	0.50

Table 3 Results of data driven mineral potential mapping in Zimbabwe applying the FAMME algorithm

Note: *True Positive (TP) and True Negative (TN) correspond to the number of grid cells, which are correctly predicted by the RF model (i.e. mineralized and non-mineralized cells, respectively). Inversely, False Positive (FP) and False Negative (FN) correspond to the number of grid cells, which are incorrectly predicted by the RF model (i.e. mineralized instead of non-mineralized cells and non-mineralized instead of mineralized cells, respectively).* ***FP indicate cells with high mineral potential****, which so far are not indicated in the mineral occurrence data base. From these data the following useful parameters are calculated: True positive rate (TPR, also "recall") = TP/ (TP+FN), False positive rate (FPR) = FP/ (FP+TN), Percentage of prospective area (PPA) = (TP+FP)/All, Precision = TP/ (TP+FP), Accuracy = (TP+TN)/All and J-score = TPR – FPR.*

The statistically most favourable factors (in decreasing importance) for exploration of each commodity are shown in Table 4.

	F1	F2	F3	F4	F5	F6
Beryllium	27	34	36	16	175	17
Lithium	34	41	38	27	19	40
Nickel_all	100	28	29	35	36	38
Nickel_lat.	slope	LP	100	srtm	40	41
Tantalum	27	36	34	16	38	35
Tungsten	34	36	27	16	6	38

6	Granite and syenite, Late Jurassic
16	Granite, Paléoprotérozoïque
17	Neoarchaean gneiss and charnockites (~2630 Ma)
19	Paragneiss, other metasediments and amphibolite
27	Phyllite and minor quartzite (Piriwiri; 2100-2000 Ma)
28	Great Dyke: Norite and gabbro (2461 Ma)
29	Great Dyke: Serpentinite and pyroxenite (2461 Ma)
34	Metasediment, felsic metavolcanic (Bulawayan; 2839-2631 Ma)
35	Andesitic and dacitic metavolcanic (Bulawayan; 2839-2631 Ma)
36	Basaltic metavolcanic with intercalated metasediment (Bulawayan; 2839-2631 Ma)
38	Komatiites and UM-M intrusions (Bulawayan; 2839-2631 Ma)
40	Older Gneiss Complex (Mesoarchaean)
41	Dolerite and gabbro intrusive (Umkondo, 1105 Ma)
100	Merged ultramafic and mafic rocks
175	Gneiss and charnockites (Palaeoproterozoic with Archaean relics)
LP	Leptosols

Table 4 Favourable factors (in decreasing importance) for the exploration of the selected ECRM's

Funded by
the European Union

Beryllium - Be

Beryllium is found in over 100 minerals but most are uncommon to rare. The more common beryllium containing minerals include: bertrandite, beryl, chrysoberyl and phenakite all of which are hosted by pegmatites, forming mostly small bodies less than one km length that are commonly shown on high-resolution geological maps (<1:25,000 scale) only. In country-scale studies, it is therefore impossible to indicate these rocks as important factor for the exploration of beryllium since they do not appear on the maps. The geographical emplacement of pegmatites appears often random but is commonly associated with the late stage of granite crystallization or within a late or anorogenic context. The *SIG-Afrique* database of BRGM indicates 237 beryl occurrences in Zimbabwe, which are widely distributed over areas with basement exposure. Major pegmatite fields are located in the Piriwiri Group of NW Zimbabwe and a smaller one east of Harare, whereas curvilinear belts with numerous occurrences are indicated in the northeast in the Zimbabwe Craton close to the boundary with the Zambezi Belt and in the southern part close to the contact with the Limpopo Belt.

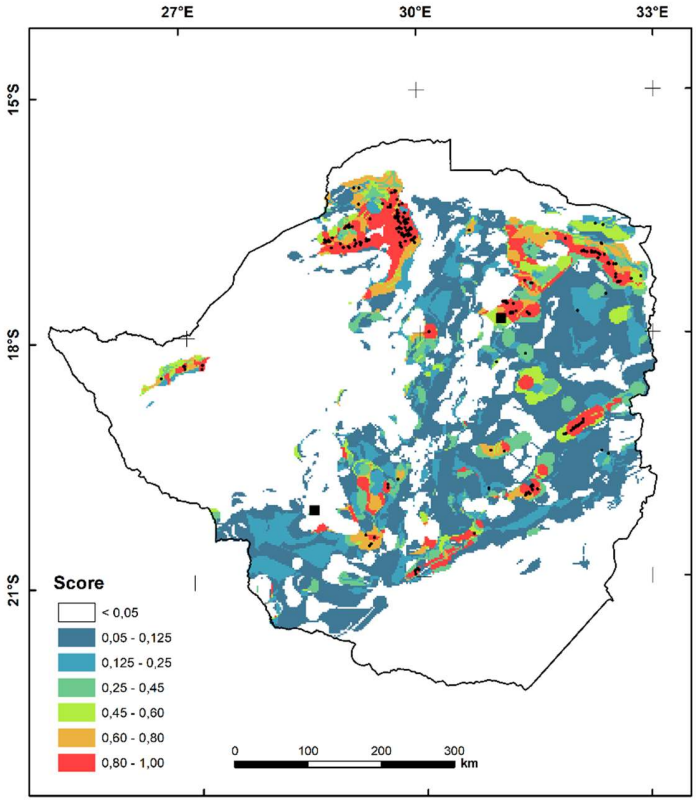


Figure 3 Mineral Potential Map of Zimbabwe for beryllium (Be). Known occurrences are indicated as black dots.

The DBA-RF model has an accuracy of ~93 % and indicates that about 6 % of Zimbabwe has potential for beryllium. The statistically most favourable factors are, in decreasing order, **27** (Phyllite and minor quartzite (Piriwiri; 2100-2000 Ma), **34** (Metasediment, felsic metavolcanic (Bulawayan; 2839-2631 Ma)), **36** (Basaltic metavolcanic with intercalated metasediment (Bulawayan; 2839-2631 Ma)**, 16**

Funded by
the European Union

(Palaeoproterozoic granite), **175** (Gneiss and charnockites (Palaeoproterozoic with Archaean relics) and **17** (Neoarchaean gneiss and charnockites (~2630 Ma).

Lithium - Li

Lithium forms several magmatic minerals in lithium pegmatites, the most important of which are amblygonite, lepidolite, petalite and spodumene. In secondary deposits lithium salts, especially lithium chloride, are also commonly found in brines and salt lakes. In Zimbabwe, 43 occurrences are recorded that are either associated with pegmatite or of unknown status. Secondary deposits were so far not identified. As the beryllium, the occurrences are located mainly within the central Zimbabwe Craton, with an additional small group in the western Magondi Belt. The same problems of statistical treatment and mineral predictivity apply as for other pegmatite hosted elements.

The data for the production of the MPM comprised the 1:2M scale geological map and structural data of Zimbabwe, the UN-CCD 500k SOTER soil map of southern Africa, the SRTM and the slope. The DBA-RF model has an accuracy of ~95 % and indicates that about 5.4 % of Zimbabwe is prospective for lithium deposits. The statistically most favourable factors are, in decreasing order, **34** (Metasediment, felsic metavolcanic (Bulawayan; 2839-2631 Ma)), **41** (Dolerite and gabbro intrusive (Umkondo, 1105 Ma)), **38** (Komatiites and UM-M intrusions (Bulawayan; 2839-2631 Ma)), **27** (Phyllite and minor quartzite (Piriwiri; 2100-2000 Ma)), **19** (Paragneiss, other metasediments and amphibolite), and **40** (Older Gneiss Complex (Mesoarchaean).

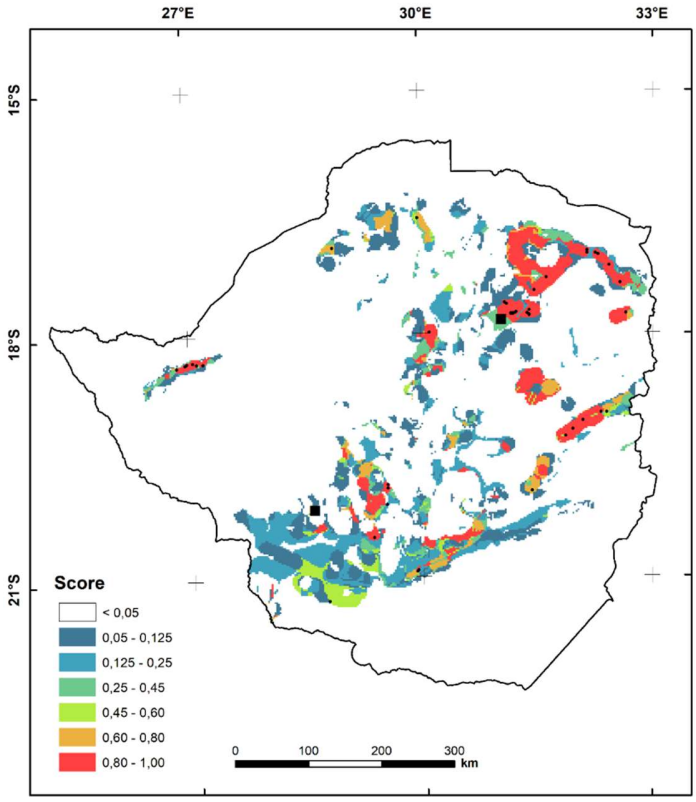


Figure 4 Mineral Potential Map of Zimbabwe for lithium (Li). Known occurrences are indicated as black dots

Funded by
the European Union

Nickel sulfides - Ni

Most nickel sulphide deposits of Zimbabwe are spatially and genetically related to mafic/ultramafic rocks within Archaean greenstone sequences and the Great Dyke. Their review shows that structural control, regional stratigraphy, and age are the best targeting criteria. These criteria were used to perform a country-scale prospectivity analysis for nickel sulphide deposits (Markwitz et al., 2000). The sulphur-rich deep marine facies of the Manjeri Formation are generally more prospective for disseminated nickel in the north and west of the craton. Nickel mineralisation occurs also often adjacent to felsic and intermediate pyroclastic rocks within major structural zones. Economic significant nickel sulphide deposits, such as Empress, Selukwe, and Shangani, are within large intrusive sills. 30 occurrences are recorded in the mineral occurrence database of BRGM (SIG Afrique).

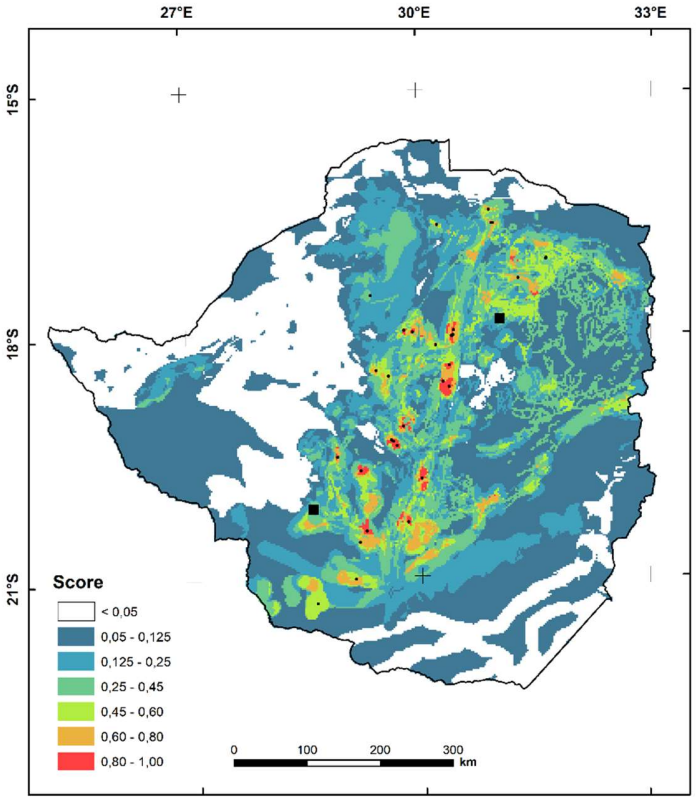


Figure 5 Mineral Potential Map of Zimbabwe for nickel sulfides (Ni); known occurrences are shown as black dots

The data for the calculation of the MPM comprised the 2M geological map and structural data (SIG Afrique, BRGM), as well as a merged layer of all mafic to ultramafic rocks (code: 100). The MPM shows high potential around most of the known occurrences within the Zimbabwe Craton and few others locations, which are considered as interesting targets for mineral exploration. Low to medium potential is shown in a wide network across the Zimbabwe Craton, mimicking roughly the greenstones. A small curvilinear belt is located in the west within the Magondi belt. The DBA-RF model has an accuracy of ~96 % and indicates that about 2.1% of Zimbabwe is prospective for nickel. The statistically most favourable factors are, in decreasing order, **100** (merged mafic and ultramafic rocks), **28** (Great Dyke: Norite and gabbro (2461 Ma)), **29** (Great Dyke: Serpentinite and pyroxenite (2461 Ma)), **35** (Andesitic and dacitic

Funded by
the European Union

metavolcanic (Bulawayan; 2839-2631 Ma)), **36** (Basaltic metavolcanic with intercalated metasediment (Bulawayan; 2839-2631 Ma)), and **38** (Komatiites and UM-M intrusions (Bulawayan; 2839-2631 Ma)). This is in agreement with the findings by Markwitz et al. (2010).

Lateritic Nickel – Ni-lat

A special study has been carried out on request for lateritic nickel, which has been reported in northern Zimbabwe. Several of these deposits overlie the ultramafic rocks at northern tip of the Great Dyke. Prendergast (2016) credited Cotterill with identifying the ultramafic rocks at the northern tip of the Great Dyke in 1970. The database for the calculation of the MPM included ten georeferenced occurrences described by Prendergast (2016), the 1:2M geological map and the SRTM and slope. SOTER Soil data were not taken into account because of their low resolution, where these soils do not occur. Only the northeastern part of Zimbabwe was analysed for this deposit style. The resulting MPM shows high potential for lateritic nickel only along the great dyke (Fig 6). Low potential is shown in few localities in the eastern part of the AOI.

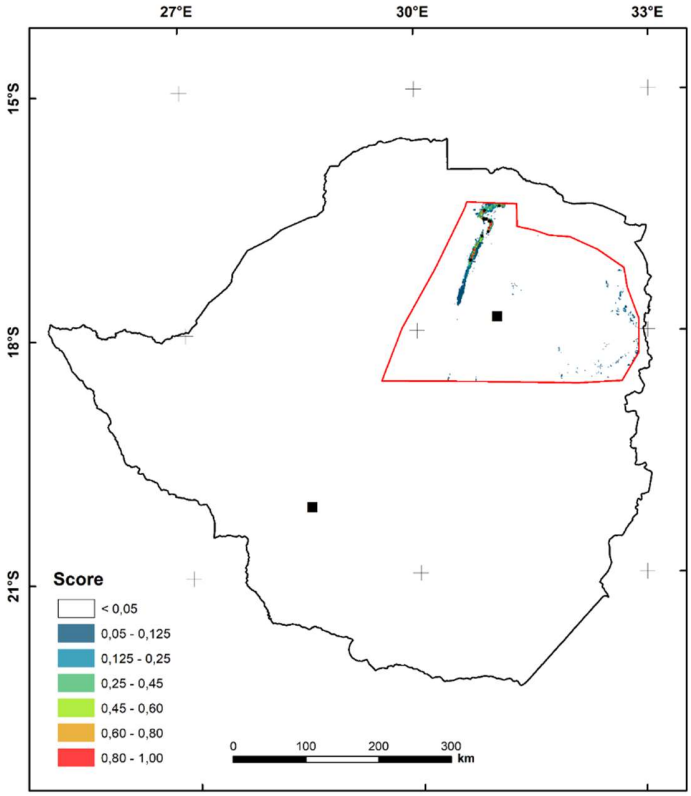


Figure 6 Mineral Potential Map of northeastern Zimbabwe for lateritic nickel; known occurrences are shown as black dots

Tantalum – Ta

Tantalum shares many of its properties with niobium (Nb), with which it is commonly found. This close association has led to use of the 'coltan' terminology, short for columbite-tantalites, reflecting the niobium-dominant (columbite) and tantalum-dominant (tantalite) end-members of this oxide mineral series. Tantalite is a dominant ore mineral of tantalum and is most commonly found within rare-metal

Funded by
the European Union

granites and pegmatites, which are suggested to account for more than three-quarters of current tantalum production (Champion, 2019). In Zimbabwe, 142 occurrences are recorded in the BRGM database (SIG Afrique), which similar to Li and Be are located principally in the central Zimbabwe Craton. The same problems of statistical treatment and mineral predictivity apply as for other pegmatite hosted commodities.

The data for the calculation of the MPM comprised the 2M geological map and structural data (SIG-Afrique, BRGM). The MPM shows areas with medium to high Ta-potential are located mainly around the known occurrences outlining two fields in the northern part of the Zimbabwe Craton (Fig 7). A third NE-SW curvilinear belt is located in the SE part of the craton, parallel to the boundary with the Limpopo Belt. Two areas of high Ta-potential but without any know occurrences are indicated west of Bulawayo and east of Harare and may represent interesting exploration targets for this commodity. The occurrences in the Magondi Belt in western Zimbabwe outline another area with medium to high Ta potential.

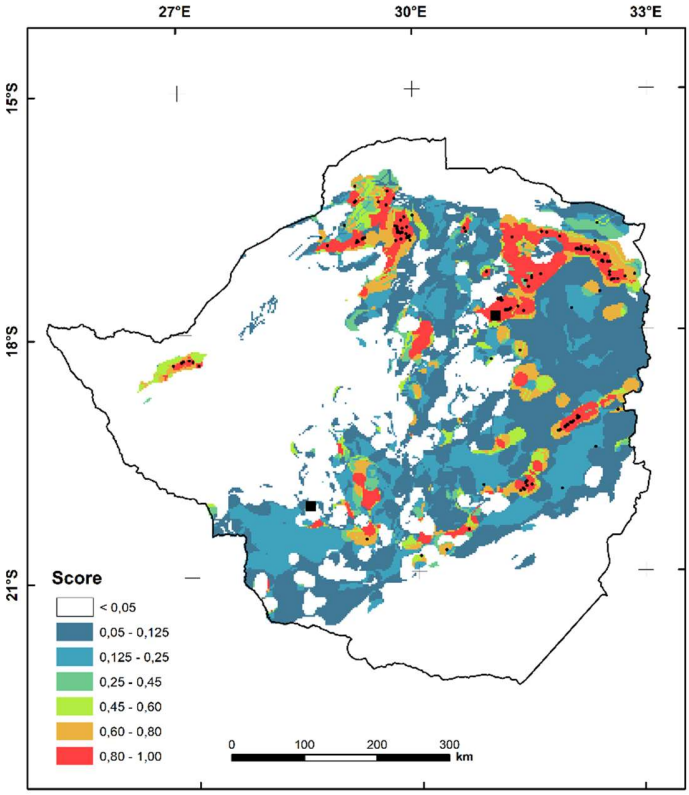


Figure 7 Mineral Potential Map of Zimbabwe for Tantalum (Ta); known occurrences are shown as black dots

The DBA-RF model has an accuracy of ~91 % and indicates that about 9.5% of the AOI is prospective for tantalum. The statistically most favourable factors are, in decreasing order, 27 (Phyllite and minor quartzite (Piriwiri Group; 2100-2000 Ma)), 36 (Basaltic metavolcanic with intercalated metasediment (Bulawayan; 2839-2631 Ma)), 34 (Metasediment, felsic metavolcanic (Bulawayan; 2839-2631 Ma)), 16 (Palaeoproterozoic Granite, e), 38 (Komatiites and UM-M intrusions (Bulawayan; 2839-2631 Ma)), and 35

Funded by
the European Union

(Andesitic and dacitic metavolcanic (Bulawayan; 2839-2631 Ma)). Structures have no influence which is probably due to poor data.

Tungsten – W

Tungsten mineralization is typically derived from granitic plutons found in a variety of tectonic environments including continental collision zones, continental rifts, and volcanic arcs along continental margins. Generally, these granites are emplaced at moderate to high crustal levels in an environment that permits brittle fracturing and migration of metal-bearing fluids into surrounding country rocks (Kirkham and Sinclair 1996). The geology and mineralogy of tungsten ore deposits can vary depending on the type of deposit, which can be classified into three main types: skarn, vein/stockwork, and porphyry. Tungsten ore is typically found in association with other minerals. Tungsten is typically found in tungstate minerals that contain varying proportions of tungsten, iron, manganese, and calcium combined with oxygen; the most common ones are wolframite ($(Fe,Mn)WO_4$) and scheelite ($CaWO_4$)[4].The BRGM database records 355 occurrences in Zimbabwe, which makes it the most frequent commodity in the country (Table 1).

The data for the calculation of the MPM comprised the 2M geological map and structural data (SIG-Afrique, BRGM). The MPM shows areas with medium to high W-potential are located mainly around the known occurrences. Major Fields are indicated southeast of Bulawayo, north, west and southwest of Harare, in the Magondi Belt and in the SE of the Zimbabwe Craton, parallel to the boundary with the Limpopo Belt. The map bears great resemblance with the tantalum and beryllium MPM's and the three commodities share four favourable factors for exploration (16, 27, 34, 36).

The DBA-RF model has an accuracy of ~90 % and indicates that about 11% of the AOI is prospective for tungsten. The statistically most favourable factors are, in decreasing order, 34 (Metasediment, felsic metavolcanic (Bulawayan; 2839-2631 Ma)), 36 (Basaltic metavolcanic with intercalated metasediment (Bulawayan; 2839-2631 Ma)), 27(Phyllite and minor quartzite (Piriwiri; 2100-2000 Ma)), 16 (Palaeoproterozoic Granite), 6 (Granite and syenite, Late Jurassic), and 38 (Komatiites and UM-M intrusions (Bulawayan; 2839-2631 Ma)). The Greta dyke shows weak but consistent W-potential along the structure.

[4] International Tungsten Industry Association, 2005

Funded by
the European Union

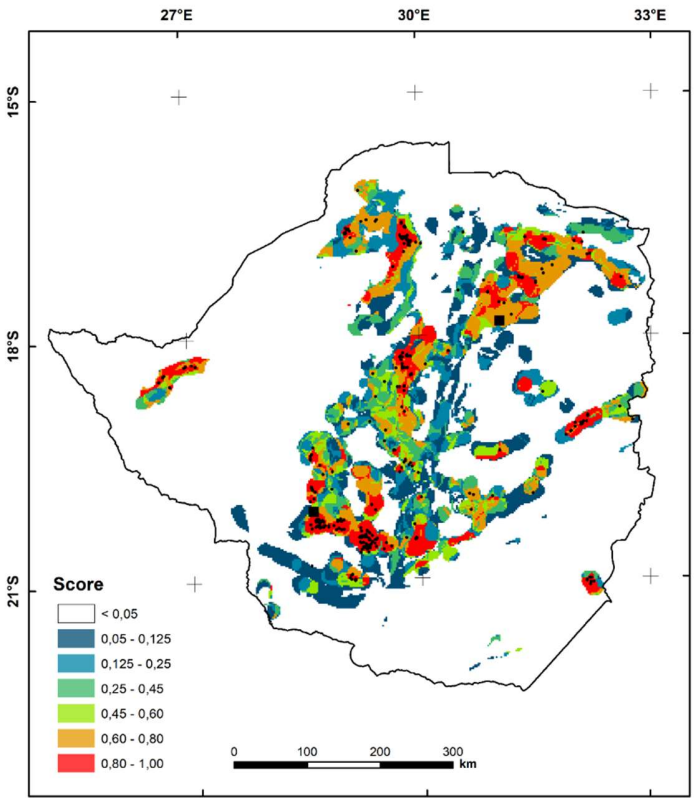


Figure 8 Mineral Potential Map of Zimbabwe for tungsten (W); known occurrences are shown as black dots

The resulting MPM shows, besides locations with known beryl occurrences, high potential in several other places. However, due to the inadequate data, this result is purely statistical and probably lacks any reality.

1.3. Ore processing and refining capacities

The majority of Zimbabwe's minerals are sold on the international markets in raw ore and mineral concentrate forms. There is an estimated 100 mineral processing facilities distributed throughout in Zimbabwe, most of which are gold or base metals processing plants. Major mining operations have their own onsite concentration, processing facilities while some small-scale artisanal miners process their ore at customer milling plants. The Zimbabwean government ban on raw lithium ore on December 21, 2022 through Statutory Instrument (SI) 213 of 2022 later replaced by the Base Minerals Export Control (unbeneficiated Base Mineral Ores) Order, 2023, on 6 January 2023 Statutory Instrument 5/2023, has seen processing CRM plants in particular lithium processing plants being put in place. At the moment, lithium processing and refining in Zimbabwe is a growing industry that has attracted significant investment mostly from Chinese mining companies. Zhejiang Huayou Cobalt's lithium processing plant at its Arcadia mine in currently has the capacity to process around 450,000 metric tons of lithium concentrate

Funded by
the European Union

annually5. Under Zimbabwean law, refined lithium can then be exported for further processing into battery-grade lithium outside Zimbabwe.

Most PGMs are sent to refineries in South Africa as flotation concentrate (Mimosa and some of Zimplats), Smelter concentrate (Unki), and Converter concentrate from (Zimplats' Selous Metallurgical Complex). The recoverable PGMs and the by-products are declared in Zimbabwe. Monthly average refined metals are 9213.6kg platinum, 7349.3kg palladium, 816.79kg rhodium, 378.4 kg iridium, and 784.26kg ruthenium. There is no osmium declared from the Zimbabwean mines. It is most likely not recovered because of its poisonous nature. The monthly average by-product production from all three operations is 1551.5kg of silver, and 18783kg of cobalt. Average copper, nickel, and gold figures were obtained but the metals are produced from three operations.

Fabrication

There is no fabrication happening in Zimbabwe. However, it is possible that some fabrication of steel products will happen after the mega Dinson Steel Manhidze Plant is completed.

[5] https://foreignpolicy.com/2023/08/16/zimbabwe-china-lithium-exports-green-technology-africa/#:~:text=The%20plant%20currently%20has%20the,battery%2Dgrade%20lithium%20outside%20Zimbabwe.

Funded by
the European Union

Name of processing entity	Processing Facility	Status	ECRM processed	Owner	Operator	Products	Processing capacity (t / day /week / month)	Production statistic (latest available data)	Other comments (Capacity expansion, etc.)
Mhangura Refinery	Refinery	Active	Copper (Cu)	Mhangura Copper Mines Ltd. [100%]					
Processing Facility - Refinery	Refinery	Closed	Copper (Cu)	Mhangura Copper Mines Ltd. [100%]				S&P Capital IQ Pro DB 2023	4.0 Very High - No Change
Empress Nickel Refinery	Refinery	Under care and maintenance	Copper (Cu)	RioZim Ltd. [100%]	RioZim Ltd.	Refined	6000 mt/y	S&P Capital IQ Pro DB 2023. USGS 2018 Minerals Yearbook, Vol. III, Zimbabwe Country Chapter, Table 2; various other USGS, industry, geologic research, and company reports; various mining databases	As of July 2022, the capacity at the Empress refinery remained at 17400 mt/y Ni. (INSG July 11, 2022). In 2022, The Refinery operated under care and maintenance throughout the period. 210 tons of matte, 78 tons of PGMs and 21 tons of copper were produced. (RiozZim 12/21 AR Mar 31, 2022). As of January 2022, RioZim Ltd planned expansion project to increase the refinery capacity from 17400 mt/yr to 45000 mt/yr. (INSG Jan 18, 2022)
Bindura Refinery and Smelter	Plant	Under care and maintenance	Cobalt (Co)	Bindura Nickel Corp. Ltd. [100%]	Bindura Nickel Corp. Ltd.	Hydroxide	700 mt/y	S&P Capital IQ Pro DB 2023. USGS 2018 Minerals Yearbook, Vol. III, Zimbabwe Country Chapter, Table 2; various other USGS, industry, geologic research, and company reports; various mining databases	Operations suspended. Capacity is a combination of Bindura Smelter and Bindura Refinery.
Empress Nickel Refinery	Refinery	Under care and maintenance	Cobalt (Co)	RioZim Ltd. [100%]	RioZim Ltd.	Hydroxide		S&P Capital IQ Pro DB 2023. USGS 2018 Minerals Yearbook, Vol. III, Zimbabwe Country Chapter, Table 2; various other USGS, industry, geologic research, and company reports; various mining databases	As of July 2022, the capacity at the Empress refinery remained at 17400 mt/y Ni. (INSG July 11, 2022). In 2022, The Refinery operated under care and maintenance throughout the period. 210 tons of matte, 78 tons of PGMs and 21 tons of copper were produced. (RiozZim 12/21 AR Mar 31, 2022). As of January 2022, RioZim Ltd planned expansion project to increase the refinery capacity from 17400 mt/yr to 45000 mt/yr. (INSG Jan 18, 2022)
Empress Nickel Refinery. Eiffel Flats, ENR	Refinery	Under care and maintenance	Nickel (Ni)	RioZim Ltd. [100%]	RioZim Ltd.	Cathodes	17400 mt/y Ni and 7000 mt/yr Cu	S&P Capital IQ Pro DB 2023. USGS 2018 Minerals Yearbook, Vol. III, Zimbabwe Country Chapter, Table 2; various other USGS, industry, geologic research, and company reports; various mining databases	As of July 2022, the capacity at the Empress refinery remained at 17400 mt/y Ni. (INSG July 11, 2022). In 2022, The Refinery operated under care and maintenance throughout the period. 210 tons of matte, 78 tons of PGMs and 21 tons of copper were produced. (RiozZim 12/21 AR Mar 31, 2022). As of January 2022, RioZim Ltd planned expansion project to increase the refinery capacity from 17400 mt/yr to 45000 mt/yr. (INSG Jan 18, 2022)
Bindura Refinery and Smelter	Plant	Under care and maintenance	Nickel (Ni)	Bindura Nickel Corp. Ltd. [100%]	Bindura Nickel Corp. Ltd.	Refined metal	15600 mt/y	S&P Capital IQ Pro DB 2023. USGS 2018 Minerals Yearbook, Vol. III, Zimbabwe Country Chapter, Table 2; various other USGS, industry, geologic research, and company reports; various mining databases.	As of July 2022, Bindura's production capacity remained to be at 14500 mt/y Ni. (INSG July 11, 2022). During the fiscal year 2015, Bindura Nickel raised a $20 million bond, of which $16.4 million was received before March year-end with an ending balance of $3.6 million. In July 2015, $1.5 million was banked and the $2.1 million balance was expected to be received by September 2015. A portion of the proceeds would be used to fund the re-opening of the Bindura nickel smelter.
Selous Plant	Plant	Active	Nickel (Ni)	Zimplats Holdings Ltd. [100%]	Zimplats Holdings Ltd.	Concentrate, Matte		S&P Capital IQ Pro DB 2023	The Selous metallurgical complex was producing matte and concentrate. (INSG Sept 28, 2020)

Funded by
the European Union

Empress Nickel Refinery	Refinery	Under care and maintenance	PGM-Platinum Group Metals	RioZim Ltd. [100%]	RioZim Ltd.			S&P Capital IQ Pro DB 2023	In 2022, The Refinery operated under care and maintenance throughout the period. 210 tons of matte, 78tons of PGMs and 21 tons of copper were produced. (RiozZim 12/21 AR Mar 31, 2022). As of January 2022, RioZim Ltd planned expansion project to increase the refinery capacity from 17400 mt/yr to 45000 mt/yr. (INSG Jan 18, 2022)
Selous Smelter	Smelter	Assumed Active	PGM-Platinum Group Metals	Zimplats Holdings Ltd. [100%]	Zimbabwe Platinum Mines (Private) Ltd.	Smelter matte, platinum group metals	72 mt/y	USGS 2018 Minerals Yearbook, Vol. III, Zimbabwe Country Chapter, Table 2; various other USGS, industry, geologic research, and company reports; various mining databases	Capacity is a combination of Selous Smelter and Metallurgical Complex.
Mimosa Concentrator	Concentrator	Assumed Active	PGM-Platinum Group Metals	Impala Platinum Holdings Ltd. [50%]	Mimosa Holdings (Private) Ltd.	Concentrate	1900 mt/y	USGS 2018 Minerals Yearbook, Vol. III, Zimbabwe Country Chapter, Table 2; various other USGS, industry, geologic research, and company reports; various mining databases	Capacity is in gross weight of ore and concentrate.
Selous Metallurgical Complex	Plant	Assumed Active	PGM-Platinum Group Metals	Zimplats Holdings Ltd. [100%]	Zimbabwe Platinum Mines (Private) Ltd.	Concentrate, platinum group metals	2180 mt/y	USGS 2018 Minerals Yearbook, Vol. III, Zimbabwe Country Chapter, Table 2; various other USGS, industry, geologic research, and company reports; various mining databases	Capacity is in gross weight of concentrate and is a combination of Selous Concentrator and Selous Metallurgical Complex.
Ngezi Metallurgical Complex	Plant	Active	PGM-Platinum Group Metals	Zimplats Holdings Ltd. [100%]	Zimbabwe Platinum Mines (Private) Ltd.	Concentrate, platinum group metals	3400 mt/y	USGS 2018 Minerals Yearbook, Vol. III, Zimbabwe Country Chapter, Table 2; various other USGS, industry, geologic research, and company reports; various mining databases	Capacity is in gross weight of concentrate and is a combination of Ngezi Concentrator and Ngezi Mine.
Msasa Plant	Plant	Assumed Active	Phosphate rock	Chemplex Corporation Ltd. [100%]	Zimbabwe Phosphate Industries Ltd.	Fertilizer	45000 mt/y	USGS 2018 Minerals Yearbook, Vol. III, Zimbabwe Country Chapter, Table 2; various other USGS, industry, geologic research, and company reports; various mining databases	
Arcadia Lithium	Plant	active	Lithium (Li)	Zhejiang Huayou	Arcadia	spodumene	4.5 million tonnes	Not available	
Bikita Minerals	Plant	Active	Lithium (Li)	Sinomine Resources group	Bikita Minerals	petalite	Petalite Plant: 480, 000 tonnes per year throughput. Spodumene Plant: 300,000 tonnes of chemical grade spodumene concentrate per year.	Not available	
Sabi star	Plant	Active	Lithium (Li)	51% by Chengxin Lithium Group and 49% by MaxMind	Sabi Star	spodumene	1million tonnes per annum	Not available	
Zulu Lithium	Plant	Active	Lithium (Li)	Premier African Minerals	Zulu mine	Spodumene	50,000 tonnes annually.	Not available	

Table 5 List of the main refining / processing units

Funded by
the European Union

2. Assessment of the ECRM value chain

2.1. Characterisation of the value chain for primary and secondary raw materials

The minerals industry value chain is a serie of industrial processing steps that adds value, both in terms of economy and usability from the discovery of valuable minerals to delivery to market as final products. These steps include mineral exploration, first-stage mineral processing, advanced stage mineral processing, product manufacturing, product marketing, and product end-of-life recycling. Each stage represents a value-add on the previous and there are opportunities to invest at each of the major stages. The mineral industry value chain is dynamic and shifts according to commodity market, which is influenced by supply and demand, price fluctuations, changing market structures, jurisdiction, and environmental concerns. An understanding of the mineral industry value chain is important for the effective management and optimization of each stage of the value chain ensuring the smooth flow of materials, maximizing resource utilization, and meeting market demand efficiently.

The stages are segmented into upstream segment, which comprise exploration, mining and first-stage processing. Activities involved in these stages include locating, extracting, and early concentration of minerals to produce first mineral concentrates, which can marketed. The downstream segment, which comprise advanced stage processing, product manufacturing, and marketing stages include refining, manufacturing of products, their marketing and utilization in various applications. The pursuit of a circular economy has spurred the advancement of recycling practices within the mineral industry. Recycling plays a dual role in this context. Firstly, products that have reached the end of their useful lives can be recycled to reintroduce minerals back into the value chain. Secondly, minerals can be recycled from mine tailings, serving the purpose of recovering critical metals or finding alternative uses such as in construction.

Throughout the different segments of the mineral value chain, some connections and linkages allow local entities and individuals to provide goods and services to the mineral sector. This creates opportunities for businesses and individuals to contribute to and benefit from the mineral industry by supplying necessary resources, equipment, expertise, and support services. Figure 9 presents the numerous opportunities along the mineral value chain.

Funded by
the European Union

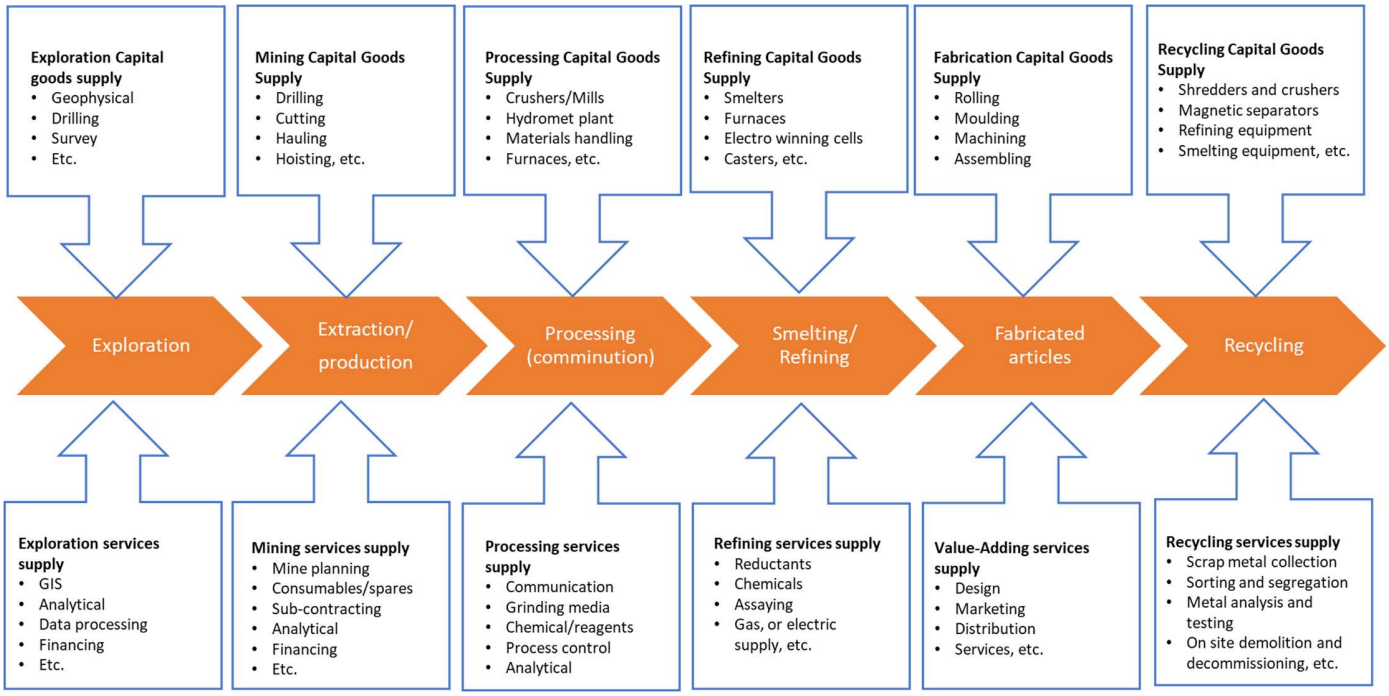


Figure 9 Schematic diagram of the general mineral value chain and the various linkages at each stage. Modified after Jourdan (2016

2.1.1 List of the mining and recycling projects (sorted by degree of maturity)

Mining is a crucial part of Zimbabwe's economy, making up over 60% of annual foreign currency receipts and 13% of the gross domestic product (GDP). The mining sector's performance reached US$5.2 billion in 2022, from US$2.9 billion in 2017 (deVere Zimbabwe, 2022). The minister of mines claims the sector has the potential to generate US$ 12 billion annually by 2023, if the government addresses challenges such as persistent power shortages, foreign currency shortages, and policy uncertainties. Legal exports of gold, Zimbabwe's top mineral export, increased from US$ 1.2 billion in 2020 to US$ 1.7 billion in 202, a 42% increase, attributed to improved output and firm prices (RBZ, 2022).

Exploration

Zimbabwe is underexplored. Modern exploration techniques such as GIS, spectral remote sensing, and high-resolution geophysics used successfully in other jurisdictions with similar geology such as Australia and Canada have not been applied in Zimbabwe. Since the mid-1990s, the Government has not been approving exclusive prospecting orders (EPO) despite mineral exploration being vital for mineral resource quantification. The country has thus lagged behind in terms of new discoveries and large-scale investments.

Zimbabwe is currently operationalizing its automated Mining Cadastre Information Management System to increase efficiency and transparency in mining title management. As a result, it was difficult to establish how many mining claims have been staked and granted throughout the country. However, based on the EPO and special grants (SG) map (Fig. 3. 2) obtained from the Ministry of Mines and Mining Development,

Funded by
the European Union

the country has 251 EPOs comprising 41 granted and 210 pending applications, and 90 SGs comprising 42 granted and 48 pending applications.

	Mineral	Estimated Resource
1	Gold	13 million tonnes
2	Platinum	2.8 billion tonnes
3	Chromite	930 million tonnes
4	Nickel	4.5 million tonnes
5	Diamonds	16.6 million tonnes
6	Iron Ore	30 billion tonnes
8	Copper	5.2 millions
7	Lithium	Has largest Africa's lithium reserve.

Table 6 Estimated endowment of the Top 7 minerals in Zimbabwe[6]

Zimbabwe's Great Dyke, a linear early Proterozoic layered mafic-ultramafic intrusion trending over 550km at a maximum width of about 11 km, has the second largest platinum reserves in the world after the Bushveld Complex in South Africa. An estimated 2.8 billion tonnes of PGMs ore at 4g/t is estimated to lounge on the Dyke. The Dyke has two PGM-bearing horizons, the Main Sulphide Zone (MSZ) and the Lower Sulphide Zone (LSZ). Major platinum mines in development in Zimbabwe include Darwendale Project Open Pit Construction, owned by Vi Holding Group; Landela Mining Venture; Fossil Contracting, Todal Bokai Platinum Mine, Matabeleland North, To be confirmed, Feasibility, Eurasian Resources Group; TransMineral, Mupani Mine, Mashonaland West, To be confirmed, Construction, Impala Platinum; Undisclosed, and Karo Platinum Project, Midlands, Open Pit, Construction owned by Tharisa and Leto Settlement Trust.

.

[6] Source: Government of Zimbabwe (2018). Investment Guideline and Opportunities in Zimbabwe

Funded by
the European Union

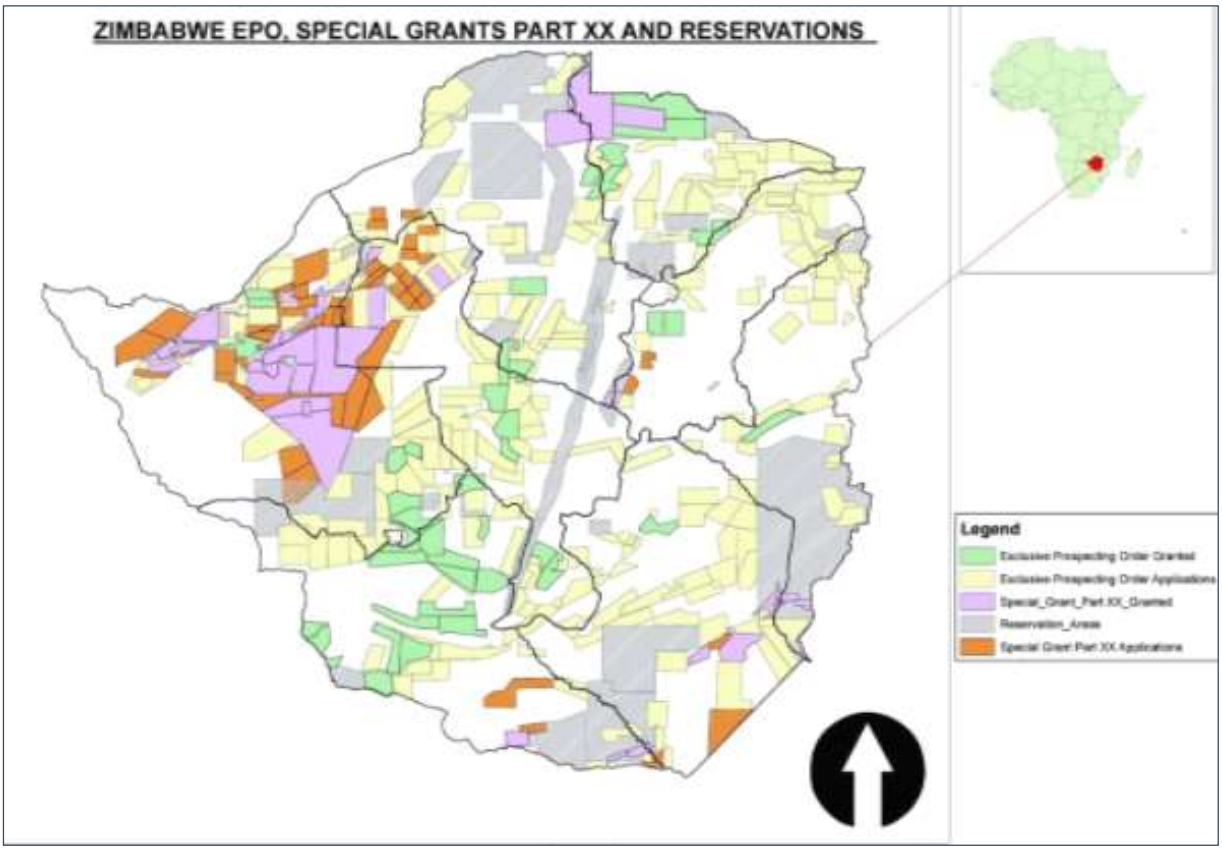


Figure 10 Zimbabwe Exclusive Prospecting Orders, Special Grants and Reservations map[7]

Mining and production

Based on data obtained from the Ministry of Mines and Mining Development, Zimbabwe has 390 operating mines (from which 3 PGMs, 1 primary nickel, 13 chromite, 4 lithium1 magnesite 1 tantalite) as of 3 October 2023, The gold mines comprise mines that are producing 0.001kg to those producing over 200kg per month.

The ECRM being mined in Zimbabwe include PGMs, lithium, tantalite, and magnesite. Antimony is produced as a by-product of gold mining, while tantalite (which contains niobium) is mainly produced as a by-product of lithium mining. Records obtained from the Mineral Marketing Corporation of Zimbabwe (MMCZ) show that there were deliveries of tungsten and manganese in 2022, the sources of these minerals are not given in the data obtained from the Ministry of Mines and Mining Development. Table 7 shows PGM mine production data from major operating mines.

[7] Source: Ministry of Mines and Mining Development (2023)

Funded by
the European Union

Name of Mine	Production (mmtpa[8]) Run of Mine
Zimplats Mine	7.21
Mimosa	2.53
3 Main Mine	2.41
Unki Mine	2.18
Mupfuti Mine	2.12

Table 7 PGMs mine production data from major operating mines[9]

Leading producers of platinum in Zimbabwe are Impala Platinum and Anglo American. During 2020-2021, Impala Platinum's output was up by 12%, Anglo American's output increased by 14%. In the context of platinum mining along the Great Dyke in Zimbabwe, the terms Main Sulphide Zone (MSZ) and Lower Sulphide Zone (LSZ) refer to specific zones within the layered intrusion. The MSZ is the most prominent layer within the Great Dyke layered that carries economic platinum-group element (PGE) mineralization. The LSZ is another layer within the Great Dyke, situated stratigraphically below the MSZ and has lower PGE grades. Current mining is focused on the MSZ while the LSZ could be a potential source of pristine PGMs sulphide ore in the future. Major operating mines in Zimbabwe are the Zimplats group of mines, Mimosa, and Unki Mines. Bindura Trojan Mine is the only operating primary nickel sulphide ore deposit. The deposit is hosted in komatiites and pyrrhotite is the main nickel sulphide mineral. Nickel, copper, and cobalt are also produced as by-products of PGMs mining at Zimplats, Unki, and Mimosa operations. There are three dormant primary nickel sulphide mines including the mothballed Shangani mine.

Table 8 shows the selected ECRMs exported in tonnes between 2018 and 2022. This was an increase of around 7.14 percent compared to the previous year.

Group	2018	2019	2020	2021	2022
PGM concentrate	130,819.00	155,940.00	98,649.48	103,064.11	112,805.93
PGM catte	15,121.00	29,903.00	34,927.80	29,503.39	37,578.57
Nickel	57,560.00	55,102.11	41,614.00	43,235.63	26,796.00
Lithium	77,244.00	60,784.00	13,068.80	26,172.18	86,871.65
Tantalite	110.65	37.61	14.95	7.30	6.45
Magnesite	5,320.00	1,000.00	2,093.00	6,078.00	5,678.87
Antimony	1,139.94	648.93	770.68	888.43	513.86
Manganese	537.00	1,000.00	2,093.00	6,078.00	5,678.87
Tungsten	62.45	37.61	58.52	17.13	38.28
Beryl	-	25.00	10.00	-	-

[8] Million Metric Tonnes per Annum
[9] Source: Global Data 2021

Funded by
the European Union

Table 8 ECRM Export volumes from 2018-2022

Zimbabwe Lithium Value Chain

Zimbabwe has 37 known lithium deposits of significant economic importance. These deposits are hosted in pegmatites. The pegmatite deposits in Zimbabwe have been classified into two major types: those occurring closely associated with Archaean greenstone belts; and those occurring within the Zambezi Metamorphic Belt (Mupaya, 2021). Greenstone belt-type pegmatites are marginal to greenstone belts and usually occur where younger granitoids intrude the greenstone belts. Pegmatites of this group are important for beryllium, tantalite-columbite, microlite, lithium, tin, and sometimes cesium. Table 9 shows the deposits and their level of maturity.

Project	Level of Maturity
Bikita Minerals	In commercial production since 1950s. Bikita has reserves of 10.8-11 million tonnes of lithium ore grading 1.4% (equivalent to about 150,000 tons of pure lithium reserves), representing 65% of Zimbabwe's total lithium reserves in 2019. BM has been mining and marketing over 60,000 tons of lithium and caesium ore per year for the past 60 years.
Arcadia Lithium	Advanced Development Project transitioning to commercial production. The project has 42.3 Mt at 1.19% Li2O (504,000t contained lithium) Code Compliant Ore Reserves in the Measured, Indicated and Inferred category and a Mineral Resource estimate of 72.7Mt at 1.11% Li2O (770,000t contained lithium) published in an ASX release dated 25 October 2017.
Sabi Star Lithium	Development project transitioning to commercial production. It has a declared mineral resource of 7Mt at 1.5% Li2O and ore reserve of 5.5Mt at 2% Li2O. Trial production commenced in August 2023.
Zulu Lithium	Development project transitioning to commercial production. It has a SMAREC Code compliant Mineral Resource of Mineral Resource Estimate of 20.1Mt at 1.06 % Li2O and 51 ppm Ta2O5 using a cut-off grade of 0.5% Li2O. Trial production commenced in April 2023.
Kamativi Mine Project	Re-evaluation underway. The project had 106,741t of spodumene ($LiAlS_2O_6$) when operations were suspended in 1995. Lithium was co-produced with tin, beryl, and tantalum. Galileo Resources, BC Ventures, and Cordoba Investments Limited are developing the project. In 2018, Chimata Gold Corp (Zimbabwe Lithium Company) announced a JORC (2012) compliant Indicated Mineral Resource of 26Mt at 0.58% Li2O within the Kamativi mine tailings.
Kamativi Lithium Project	Early-stage exploration project whose prospectivity is centered on its proximity to the Kamativi Mine. Galileo Resources is developing the project.
MIRRORPLEX Lithium Project	Early-stage exploration project reportedly with huge potential. So far, 240 rock chip samples have been collected from the Bonnyvale and Loch Ness Pegmatites returning up to 3.13% Li2O, and 4.82% Li2O respectively. The project is speculated to be sitting on 6Mt of lithium (Mining Zimbabwe, September 30, 2022).
Step-Aside Lithium Project	Early stage exploration Project. Prospectivity is based on mineralized LCT pegmatites.
Mistress Lithium	Project under care & maintenance. Mupaya (2021), using a geological factor method (pegmatite parameters), estimated an inferred global resource of 39, 195 000t of

Funded by
the European Union

	spodumene, 29,475,000t of lepidolite, 3,888,00t of muscovite-lepidolite, 98,615,500t of feldspar, 53,559,500t of silica, and 45,000t of beryl.
Benson Lithium	26t of lithium concentrate was co-produced with tantalum in 1954, and 1955. The project is under re-evaluation.
Good Days Lithium	A resource of 30Mt Spodumene and lepidolite historically co-produced with beryl. Project under re-evaluation
Sandawana	Exploration project. Confirmed lepidolite and spodumene mineralization.
Bepe	Exploration project:45t of lithium was co-produced with tantalum in 1967
Blarney	Exploration project: 28t of lithium concentrate was co-produced with beryl in 1956
Bobby	Exploration project: 36t of lithium concentrate was co-produced with beryl in 1963
Bomb	Exploration project: 91t of lithium concentrate was co-produced with beryl in1957,and 1981
Casa Ventura	Exploration project: 606t lithium concentrate was produced in 1957, and 1981
Embizemi	Exploration project: 50t of lithium concentrate was produced in 1967
Pfungwe Gem	Exploration project: 601t of lithium concentrate was co-produced with beryl in 1969. Currently under exploration license.
Good Days	Exploration project: Spodumene, lepidolite with beryl 1970-72
Grand Duke	Exploration project: 103t of lithium concentrate was produced from 1927-70
Green Mamba	Exploration project: 54.4t lithium concentrate was co-produced with beryl in 1962
Guardian	Exploration project: Exploration project: 82t of lithium concentrate was co-produced with tantalum in 1968 and 1969
Gwaai	Exploration project: 74t of lithium concentrate was co-produced with tantalum and tin in 1953,and 1954
Kalinda	Exploration project: 23t of lithium concentrate was co-produced with tin in 1938
Kapata	Exploration project: 4t of lithium concentrate was co-produced with tin in 1954
Lutope	Exploration project: 238t of lithium concentrate was co-produced with tin in 1953,and 19 54
Matake	Exploration project: 130t with beryl 1982, 83
Mauve	Exploration project: 4922t of lithium concentrate was co-produced with tantalum in between 1952-1958
Mbeta	Exploration project: 496t of lithium concentrate was co-produced with tantalum between 1954 and 1960.
Mops	Exploration project: 36t of lithium concentrate was co-produced with beryl in1955
Patronage	Exploration Project: Spodumene, lepidolite, cassiterite, microlite, tantalite, and beryl. 72.6t spodumene, 1531t petalite+ lepidolite, and 227t eucryptite. 1967-68
Porte	Exploration project: 1044t of lithium concentrate was co-produced with tantalum between 1969-1970
Tagara	Exploration project: 3t of lithium concentrate was co-produced with talc in 1975
Vee Cee	Exploration project: 254t of lithium concentrate was co-produced with tin in 1969 and 1970
Vulcan	Exploration project: 36t of lithium concentrate was produced in 1957
Winston	Exploration project: 1122t of lithium concentrate was produced between 1953 and 1967

Table 9 Zimbabwe lithium deposits with their levels of maturity

Funded by
the European Union

Bikita mine

The Bikita mine, which has recently been bought by China Sinomine Resource Group, is located in south-East Zimbabwe. The mine has been periodically mined since tin was discovered in 1910, lithium mining (petalite) commenced in the 1940s. The graded petalite concentrate product produced on-site was sold to the United States of America mainly for glass and ceramics (Goodenough et al., 2021). Tantalite has historically been co-produced with lithium at the mine. The mine historically employed both open pit and underground mining methods to extract lithium ore that undergoes comminution on an onsite concentration plant. In January 2022, the new owners, Sinomine Resources Group commissioned a new processing plant with a capacity to produce 300,000 metric tonnes of spodumene concentrate and 480,000 metric tonnes of petalite per year. The processing facility comprises a Gravity Separation Plant and a Flotation Plant (Bikita Minerals, 2022). The Gravity Separation Plant produces the petalite concentrate and has capacity to process 2 million tonnes of ore per year, while spodumene concentrate is produced in the flotation plant. The lithium spodumene oxide is shipped to China for production of lithium hydroxide and lithium carbonate for manufacture of cathodes and electrolytes for rechargeable batteries.

Arcadia lithium project

The Arcadia lithium project is located 38 km east of the capital city Harare. The property was, acquired from Prospect Resources by Zhejiang Huayou of China for $422 million in December 2021. Arcadia lithium project is an advanced development project transitioning to commercial production. It has a 42.3 Mt at 1.19% Li_2O (504,000t contained lithium) Code Compliant Ore Reserves in the Measured, Indicated, and Inferred category and a Mineral Resource estimate of 72.7Mt at 1.11% Li_2O (770,000t contained lithium) published in an ASX release dated 25 October 2017. Zhejiang Huayou Cobalt commissioned the plant in April 2023, and announced the export of 30,000 metric tonnes after the plant went into trial production.

The Arcadia lithium deposit is hosted within a series of 14 stacked, subparallel petalite-spodumene-bearing pegmatites, intruding the Harare Greenstone Belt (HGB). Drilling results identified pegmatites with an average thickness of 15m and extending up to 3.5km along the strike. Most of the economic lithium mineralization found at Arcadia comprises petalite and spodumene. The crystallization of petalite is expected to have occurred prior or co-genetically with primary spodumene. Secondary mineralization is thought to have occurred through the conversion of petalite and spodumene to spodumene, quartz intergrowth, and eucryptite.

The Arcadia Mine is a conventional truck-and-shovel open pit mining method operation. The ore is extracted by drilling and blasting of the ore rock. A contractor carries out the mining, loading, hauling and dumping of the ore and waste. The run of mine with a head grade of 1.19%Li2O is undergoes crushing followed by high pressure grinding rolling to achieve a 5mm crush size required to achieve optimal liberation of petalite for primary recovery by dense media separation technique. The run of mine (ROM) with a head grade of 1.19%Li_2O undergoes crushing and screening followed by high-pressure grinding rolling (HPGR) to achieve a 5mm crush size required to sufficiently liberate petalite for recovery by dense media separation (DMS) technique to produce a 4% (82%) petalite concentrate product of which 80% is 1.7mm, with less than 0.05% Fe_2O_3 technical grade petalite concentrate, and 20% 1.7mm to +0.6 mm

Funded by
the European Union

chemical grade petalite concentrate product. The post-gravity recovery reports to the flotation circuit where spodumene is effectively recovered at a grind size P100 of 0.212mm (P80 0.150mm). Fatty acid flotation is used to recover a spodumene concentrate of 6% Li_20; i.e. 75% spodumene. Spodumene concentrate will be cleaned, and upgraded, by employing mica flotation at low pH followed by WHIMS to reduce iron contamination. The mica concentrate will be set aside pending the potential identification of a potential commercial opportunity to realize value from this product.

Tantalite is recovered in a dedicated spiral circuit placed in the flotation tailings stream. The rough tantalite is upgraded to a saleable product containing approximately 25% Ta_2O_5 by the use of conventional gravity concentration methods and magnetic separation. The Arcadia plant is planned for a total annual production of 450,000 metric tonnes of lithium concentrates comprised of 147,000 metric tonnes per year of spodumene, 94,000 metric tonnes per year of technical grade petalite, and 24,000 tonnes per year of chemical grade petalite concentrates.

Sabi Star lithium project

Sabi Star Mine is owned 51% by Chengxin Lithium Group and 49% by MaxMind, all Chinese companies is an advanced development project transitioning into commercial production. Trial production commenced in August 2023. The project has a declared mineral resource of 7Mt at 1.5% Li_2O, and 200-ppm Ta_2O_5, and ore reserve of 5.5Mt at 2% Li_2O and 200ppm $_{Ta2O5}$. The operation is expected to produce 1Mtpa Run of Mine (ROM) to be processed via gravity and flotation concentration methods to recover spodumene concentrate. At full operational capacity, the 1Mtpa ore will translate to 300,000t lithium concentrate, and 300t of tantalum-niobium concentrate per year.

Lithium-bearing mineral (spodumene) is recovered from the mining of pegmatite deposits by open-pit method. The ROM ore is transported to the plant on site where it undergoes primary and secondary crushing, screening before it is fed to the ball mill for grinding to produce a slurry. Dense media separation technique is used to separate tantalite from the spodumene concentrate. The spodumene concentrate undergoes flotation to remove the gangue material. The remaining fine tantalum is removed by magnetic separation to produce fine tantalum and 4.5% minimum Li20 spodumene concentrate. The spodumene concentrate is dried via filter pressing. The concentrate still has a 9% moisture content, is bagged and sent to China for further processing to produce battery-grade lithium hydroxide and lithium carbonate.

Zulu lithium project

Located near the village of Fort Rixon, 100km southeast of Zimbabwe's second city of Bulawayo in Matebeleland South Province, the Zulu Lithium project is owned by Zulu Lithium (Pty) Limited, a subsidiary of Premier African Minerals of United Kingdom (UK). Zulu lithium project is a massive, surface outcropping, steeply dipping, pegmatite hosted lithium deposit. The orebody thickness ranges between 5m to 30m. The deposit is amenable to open-pit mining. The property has reported a maiden SAMREC code-compliant inferred mineral resource estimate of 20.1Mt at 1.06% Li_2O and 51 ppm Ta_2O_5 using a cut-off grade of 0.5% Li_2O.

The Zulu lithium project commenced trial production in April 2023. Lithium-bearing minerals, spodumene, and petalite are co-produced with tantalite from mining of pegmatite deposits through open-pit method

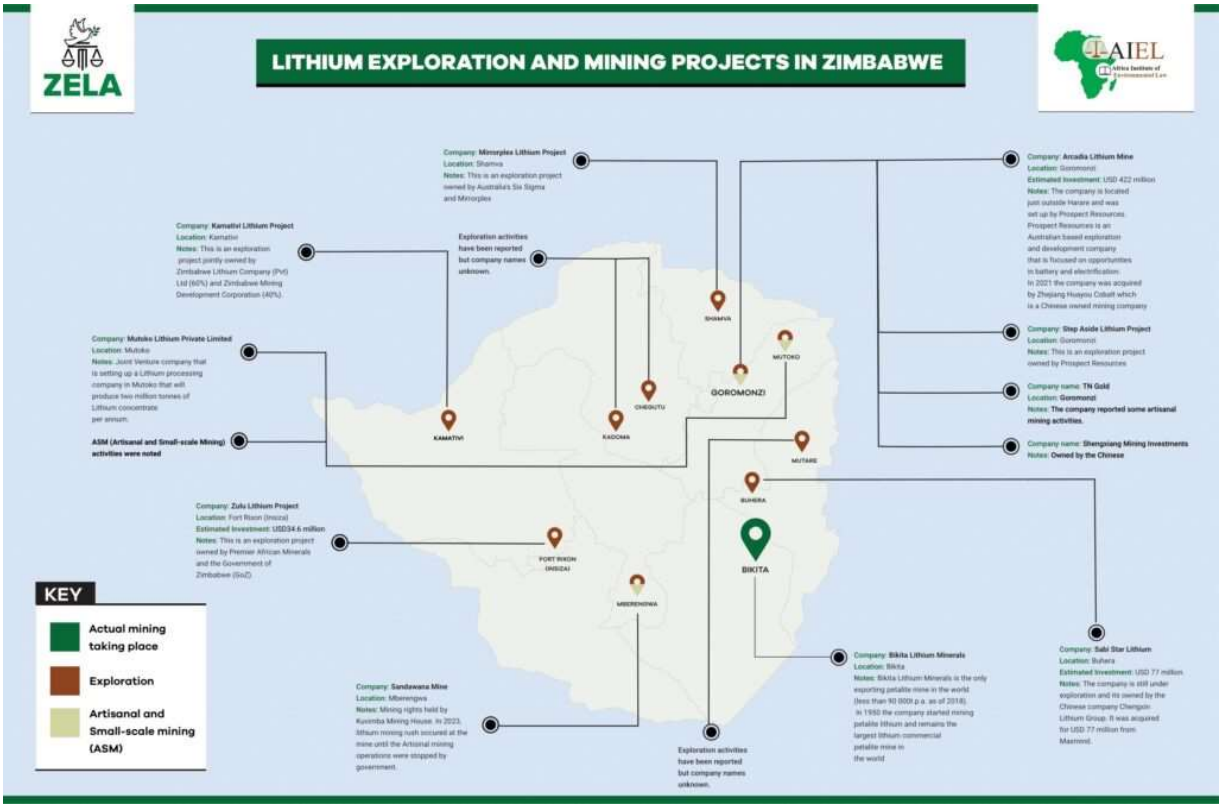
Funded by
the European Union

(Premier African Minerals, 2017). Ore excavation is by standard drill, blast, truck and shovel methods. The run-of-mine ore undergoes comminution that includes three stages of crushing; jaw crushing, secondary crushing, and tertiary cone crushing followed by separation by screening method to produce the -0.5mm +0.5mm fraction, and -0.5mm fraction products. The -0.5mm +0.5mm fraction screen product undergoes a two-stage cyclone-based dense media separation, initially to separate the heavier spodumene from lighter petalite and micas, and the second-stage separates petalite from the micas to produce spodumene and petalite concentrates.

The DMS spodumene is milled and further concentrated by flotation method to produce a 6.24% Li_2O spodumene. The spodumene concentrated is thickened, filtered and bagged prior to shipping to market. The DMS petalite concentrate product is milled and subjected to high-intensity magnetic separation to remove most of the iron and manganese before further concentration by flotation method to produce a 3.9% Li_2O spodumene concentrate. The petalite concentrate is filtered and bagged before shipping to market (Bara, 2017).

Lithium value chain summary

Lithium production in Zimbabwe is restricted to the upstream phase of the value chain. The production involves exploration and extraction of lithium ore minerals (spodumene and petalite) from pegmatite deposits and beneficiation of the ore to produce a lithium oxide mineral concentrate sold to overseas markets for further processing. Currently, extraction and processing of lithium ore is carried out at Bikita Minerals, Arcadia, Sabi Star, and Zulu operations.



Funded by
the European Union

Figure 11 Map of the Lithium exploration and mining projects in Zimbabwe

Zimbabwe PGM value chain

Three operations, Zimplats, Unki, and Mimosa, in commercial production, dominate Zimbabwe's PGMs value chains. Kadoma Platinum (Karo Resources) and Darwendale Platinum Project (Great Dyke Investments) and Todal Bokai Lithium (CAMEC-ZMDC) projects are advanced exploration stage projects with declared code-compliant mineral reserves and resources. Table 10 shows Zimbabwe's PGMs projects of significant economic importance with their levels of maturity.

Project	Level of maturity
Zimplats	In commercial production. Operates five mines with combined ore production of 7.1Mtpa, Two concentrators with combined capacity of 4.4Mtpa. Exported 623,000 ounces of 6E in matte/concentrate in 2022. (Zimplats, 2022).
Unki	In commercial production: Production is from two decline shafts feeding an onsite plant with a production capacity of 210ktpm.
Mimosa	In commercial production: The ore is processed in the on-site concentrator at a rate of 227,000t per month. The project has a steady-state platinum production capacity of 115,000oz a year. The mine produced 25,000oz of concentrate at a grade of 3.85g/t platinum.
Mimosa North Hill Project	It is an advanced exploration project with a full feasibility study. North Hill is being considered as a life extension for Mimosa due to mining depletion risks at the South Hill from 2029 onwards. It is estimated that the current South Hill Mineral Reserves will sustain the operations until 2034. It targets an area with 6.65Moz 4E Mineral Resources, and will extend the LoM at current rates (+230kOz per year) to ~2044 (+ 8 years). Surface exploration drilling is being carried out in Mtshingwe and Wedza West sections to convert Indicated to Measured Mineral Resources and eventually to prove Mineral Reserves.
Kadoma (Karo Resources)	Advanced exploration project with a code-compliant resource. Open pit. SAMREC code (2016) compliant resource of 109.58Mt at 2.04G/t 5PGE +AU, 0.10% Cu, 0.125% Ni, 0.005%Co. as at September 2022. Karo Resources (2022).
Darwendale (Great Dyke Investments)	Advanced exploration project with a code-compliant resource of 181.3Mt at 1.60g/t Pt and 2.93g/t of 4E containing 17.1 million ounces (Moz) of PGMs and gold in the measured and indicated categories.
Todal Bokai Project	Todal Mining Ltd is a 60/40 joint venture between CAMEC subsidiary Lefever Finance Limited and the state-owned Zimbabwe Mining Development Corporation (ZMDC). 135 million tonnes at 3.5 g/t inferred. Bokai's Phase 1 annual output was expected to reach 180,000 ounces of PGM.

Table 10 Zimbabwe PGMs projects with their level of maturity

PGMs in Zimbabwe are recovered from pristine sulphide ore mined from the Main Sulphide Zone (MSZ) in different sub chambers of the Great Dyke. The Great Dyke is a 550km NE-SW trending, 4km to 11 km wide, 2.5Ga layered magmatic ultramafic intrusion that cuts across the Zimbabwe craton. The intrusion is

Funded by
the European Union

made up of two main chambers, the northern and southern chambers (Chaumba, 2017). The northern chamber has been further subdivided into Hartley, Sebakwe, and Musengezi sub chambers while the southern chamber has been divided into the Selukwe and Wedza sub chambers. The Darwendale and Sebakwe sub chambers are by far the largest and economically most significant. Together, they contain approximately 80% of the Great Dyke's total PGM resources (Gunn & Brenham, 2009; Wilson & Prendergast, 2001).

The MSZ is a 2-8m; locally up to 20m thick zone hosted within a pyroxenite located 10 to 50m below the mafic and ultramafic contact. PGMs occur in pyrrhotite, pentlandite, and chalcopyrite. Palladium and ruthenium are preferentially hosted in pentlandite, while platinum occurs as discrete PGM grains in essentially bismuthotellurides, sulphides and arsenides. The PGMs of MSZ are characteristically fine-grained (<5µm to 250µm) within sulphides (Johan et al., 1989).

The MSZ is characterized by zones of distinctive fine structures caused by successive vertical distribution of palladium, platinum and base metal sulphides. Palladium and ruthenium are preferentially hosted in pentlandite, while platinum is dominantly occurs mainly in the form of discrete PGM grains, mainly bismuthotellurides, sulphides, and arsenides. Gold, silver, asbestos, chromium, nickel, copper, and cobalt also occur in the Great Dyke. Nickel, copper, and sometimes cobalt, are produced as by-products of PGM mining while gold is produced as part of a family. Chromites are found at the bases of cyclic units in the lower ultramafic part of the intrusion. The chromites carry sub economic PGM contents (Oberthür et al, 2002).

Zimplats PGM operations

At Zimplats operations, PGMs are recovered from pristine sulphide minerals mined by mechanized, bord, and pillar underground mining method from five different mines (Ngwarati, Rukodzi, Mupfuti, Bimha, and Mupani) with a combined run-of-mine tonnage of 7.1Mtpa feeding two concentrators (Ngezi 1 and Ngezi 2) with a combined capacity of 4.4Mtpa (Zimplats, 2022). The ROM undergoes a process of crushing, milling and flotation and filtration concentration at each of the two concentrators to produce a filtered flotation concentrate product which is sent to the company's Selous Metallurgical Complex for treatment through a smelter and convertor concentrator to produce a converter matte which is sent to Impala Refining Plant in South Africa for refining and marketing (Mabiza 2006; Zimplats 2022).

The Run-of-mine ore is ground in a Fuller Traylor SAG mill before flash flotation to recover a coarse, high-grade primary concentrate, ahead of regrinding, and rougher and scavenger flotation.

Concentrates produced by flotation are smelted, and then converted to give a final low-iron matte, containing 44% nickel, 33% copper, 21% sulphur and 1,500g/t precious metals, that is sold to Impala Refining Services for subsequent precious-metals recovery (Mining Technology, 2021). Zimplats uses a Larox PF 25/32 filter press with a production of 10.2 tonnes dry solids equivalent per hour at 15% moisture to produce a 45mm thick concentrate cake. A Drytech flash dryer with a throughput of 10,600 tonnes per month dry weigh is used to evaporate water from the filter cake to produce a dried concentrate cake with a moisture content averaging 0.2% to 0.3%. The dried cake product is smelted in a modified Elkem-Hatch Furnace to produce nickel sulphides, copper sulphides, iron sulphides, and minor levels of cobalt together

Funded by
the European Union

with the PGMs and other precious matte (smelter matte). Two Peirce-Smith converters with 22 tuyeres are utilized to produce converter matte of 0.6% Fe from the smelter furnace matte containing 42% Fe and 31% Sulphur. The converter is sent to Impala Refining Plant in South Africa, for PGM and base metal refining and marketing (Mabhiza, 2006). Zimplats has set aside US$ 200million to build a PGM and base metal refinery locally. There are 10 metals produced by Zimplats, namely: platinum, palladium, rhodium, ruthenium, iridium, silver, gold, nickel, copper, and cobalt.

Unki mine

At Unki mine, PGMs are extracted from pristine sulphide minerals mined from the MSZ of the Selukwe Sub chamber of the Great Dyke using a fully mechanized bord and pillar underground mining method. The mining cycle involves the use of Fletcher D914L 1.5m bolts fixed at 1.5m x 1.5m grid for roof support followed by the use of XRF (X-ray fluorescence), visual inspection, and chemical analysis to identify the reef. A Sandvik Axera DD210L 3m hole length with a diameter of 45mm is used for drilling production holes, followed by charging and blasting. At Unki, re-entry for safe making, cleaning and lashing is done 2 hours after blasting. A Gutehoffnungshütte Aktienverein (GHH) Sandvik LH208 is used to transport ore to the grizzly where the ore undergoes sizing ahead of hoisting to the plant on surface by conveyor belts.

Unki mine ore concentration process involve further on surface ore size reduction by crushing and milling in primary autogenous mill at a top size of 300mm of ROM with a head grade of approximately 3.50g/t 4E to produce a 40-45% passing 75µm feed to primary flotation. In the primary flotation, sulphides are removed in the froth using collectors, depressants, and purging and passed on to a cleaner flotation cells to produce a final flotation with the aid of additional depressants. Secondary flotation recovers the further liberated sulphides in a secondary rougher flotation tank. The two concentrates constitute the final concentrate product with a grade of approximately 100g/t 4E. The concentrates are two-stage thickened before final filtration in a Larox PF933 press filter to produce a concentrate cake of 16% moisture. This concentrate cake is the feed to the smelter. Unki smelter treats 62ktpa concentrates from the Unki concentrator. The smelter uses a three-electrode 8.5MW electric arc furnace to melt fluxed concentrates into smelter matte with a grade of 248g/t PGM, and slag. The matte is manually broken and then crushed in a three stage crushing plant to produce a -4mm matte of 248g/t content, which is shipped to Angloplats refinery in South Africa for conversion, refining and marketing. There are 9 metals produced by Unki, namely: platinum, palladium, gold rhodium, iridium, ruthenium, nickel, copper, and cobalt (Musa, 2023).

Mimosa mine

Having commenced operations in 1926, Mimosa mine is the oldest PGM mine in Zimbabwe. The mine is situated in the Wedza sub chamber of the Great Dyke of Zimbabwe. PGMs are recovered from pristine sulphide mineralization of the MSZ mined by fully mechanized bord-and-pillar underground mining method from four erosional isolated and fault-bound blocks, namely North Hill orebody, South Hill Orebody, Mtshingwe Fault Block orebody, and Far South Hill orebody. Each of these blocks is host to a pyroxenite layer known as P1 pyroxenite layer, which is overlain by a layer of gabbro. The PGMs-bearing MSZ is located in the P1 pyroxenite some 10m below the ultramafic/mafic contact. The MSZ is a continuous layer, 2m to 6m thick, and forms an elongated basin in the Wedza sub chamber. The zone

Funded by
the European Union

strikes in a north-north easterly trend and dips at 14°C on the margins flattening towards the axis of the basin. The MSZ at Mimosa has a well-defined grade profile where peak base metal and PGM values are offset vertically, with palladium dominant towards the base, platinum in the centre and nickel towards the top. At Mimosa, the MSZ is visually identified using pyroxene and sulphide mineralization followed by confirmatory channel sampling and underground XRF (X-ray fluorescence) channel definition.

PGM extraction starts underground with drilling, charging and blasting of sulphide ore. The daily production routine involve support drilling to make working stations safe for men and equipment, face preparation, face drilling, charging and blasting, and lashing of the ore. Ore is transported to underground bunkers by conveyor belts, and then to surface stockpile. At the processing plant, the run-of-mine ore (ROM) undergoes primary, secondary and tertiary crushing, and wet milling to produce a pulp in the on-site concentrator at a rate of 227,000t per month. The pulp is fed into flotation tank cells and reagents are added to change the chemistry of the pulp. Tailings are de-watered and pumped to tailing storage facility. The recovered concentrate is thickened and filtered to produce a concentrate product with a grade of 3.85g/t platinum. The product is transported by road to Impala Platinum facilities in Rustenberg, South Africa, for smelting, converting, and refining ahead of marketing. Mimosa has a steady-state platinum production capacity of 115,000 Oz a year (Mimosa, 2023). There are 6 metals produced by Mimosa, namely: platinum, palladium, rhodium, gold, iridium, and ruthenium (Mimosa, 2023).

PGM value chain summary

The level of Zimbabwe PGM value chain development is operation based. The value chain has developed to the refining stage at the Zimplats operations. However, because of a lack of capacity, a big portion of the PGM concentrate produced at the two concentrators (Ngezi 1 and Ngezi 2) is shipped to South Africa, for smelting, converting, refining, and marketing. Unki mine value chain has developed to the smelting stage. The smelter matte concentrate is sent to South Africa for conversion, refining and marketing. There are no plans to install further downstream processing facilities as the current scale of production will not justify such installation. However, it is possible that Unki could utilize facilities at Zimplats on a toll arrangement. Value chains at Mimosa Mine are the least developed of the three mines in commercial production. Mimosa's value chain is restricted to the concentration stage of upstream segment where a thickened an filtered flotation concentrate product is sent to South Africa for smelting, conversion and PGM and base metal refining before marketing. PGM recycling is also going on in Zimbabwe.

Zimbabwe has more than sufficient resource base to justify the development of the entire PGM value chain locally.

Nickel value chain

Zimbabwe nickel value chains

Four companies that are producing nickel at four different operations (Bindura Nickel Corporation, Zimplats, Unki, and Mimosa) dominate Zimbabwe nickel value chain. Kuvimba Mining House is producing nickel at Trojan Nickel operation through its subsidiary Bindura Nickel Corporation, Ngezi Platinum, Mimosa, and Unki are producing nickel as a by-product of PGMs mining at Ngezi Platinum mine, Unki Platinum mine, and Mimosa Platinum mine respectively. Kuvimba Mining House also owns a number of

Funded by
the European Union

nickel projects some of which are previously producing mines under care and maintenance or are exploration projects at various stages of exploration. Zimbabwe has 37 recorded nickel deposits seven of which are associated with PGMs. Table 11 shows Zimbabwe nickel projects of significant economic potential with their levels of maturity.

Nickel Project	Level of Maturity
Trojan Nickel Mine	Producing mine with resource including measured, indicated and inferred resource of 8.59Mt at 1.00% Ni as at 32 March 2021.
Trojan Hill	Resources declared
Kingstone Hill	Resources declared
Mimosa PGM	Producing mine with a declared resource of 129Mt at 0.14%, Ni produced as a by-product of PGMs mining.
Unki PGM	Producing mine with a declared resource of 226Mt at 0.22%, Ni produced as a by-product of PGMs mining.
Zimplats PGM	Producing mine with a declared resource of 2,060Mt at 0.12%, Ni produced as a by-product of PGMs mining.
Kadoma PGM	Advanced exploration project with Nickel resources associated with PGMs.
Empress	Old Dump highly important. Drilling of plus 10,000m on extension of the old mine-results good. Past production of 18Mt at 0.7%Ni mined by Rio Tinto.
Perseverance	Past producing with 0.83t at 1.01%, Ni mined.
Madziwa	Past producing mine with disseminated and massive sulphides, especially in meta-pyroxenite (Bartholomew, 1990); mineralization confined to two distinct ore bodies: Amm's and Sulphide Hill. Nickeliferous ore bodies formed along fractures in Archaean granitic terrane by digesting granitic xenoliths (Chimimba, 1986).
Shangani	Under care and maintenance operation with measured, indicated and inferred resource of 12.03Mt at 0.56% Ni as at 31 March 2021.
Epoch	Past producing mine with structurally controlled nickel mineralization in a well foliated serpentine-talc-magnesite schist (Bartholomew, 1990; Prendergast, 2003).
Hunters Road	Advanced exploration stage project with measured, indicated and inferred resources of 36.4 Mt at 0.55%Ni as at 31 March 2021.
Darwendale Project	Advanced exploration project with Nickel resources associated with PGMs.
Bend	Early stage exploration project. Nickel mineralization occurs at the base of a thick upper komatiitic flow. Deposit lies well above the Manjeri unit (e.g., Prendergast, 2003).
Elmo	Early stage exploration project with mineralization in a serpentinized zone at the contact of gabbro with pyroxenite in a mafic-ultramafic complex intruding granites and metasediments (Bartholomew, 1990
Damba-Silwane	Discovery stage exploration project. Fault controlled Nickel sulphide mineralization occurs in a 7 km komatiitic succession overlain by tholeiitic lavas (Bartholomew, 1990); 5 ore bodies in peridotite on Sebakwian/Bulawayan contact (Wilson, 1979) and each of them are interpreted to be associated with a discrete lava channel complex (Prendergast, 2003). Fault-controlled nickel sulphide mineralization and low-grade metamorphism (Killik, 1986).

Funded by
the European Union

Hills Prospect	Discovery project with Resource of 10MT at 0.4% TNi or 3MT at 0.6% TNi, Significant potential in Laterites-Potential for : 2.23Mt at 0.86%TNi
Lower Gweru	
Matopos Dam	Early stage exploration project historically evaluated by geochemical survey and drilling -information not found. Falcon Bridge did some work on it. However, no Information was obtained.
Noel	Early stage exploration project
Warwick	Early stage exploration project with nickel mineralization in serpentinized dunite body regarded as subvolcanic sill emplaced along the contact between dacitic lavas and tuffs and overlying komatiitic lavas (Bartholomew, 1990)
Zinca	Past producing mine where nickel was produced as a by-product of PGM mining.
Mistake	Discovery stage exploration project with a declared resource of 1.56Mt grade-0.50% TNi over 250m strike 70m depth. (Bishi and Chikutiro, 2022).
Broomrigg	Discovery stage exploration project with a declared resource of 500,000 mt oxide ore at 0.56% TNi. Bishi and Chikutiro (2022).
Nickel Hill	Discovery stage exploration project with a declared resource of 10Mt at 0.4% TNi or 3Mt at 0.6% TNi, Significant potential in Laterites-Potential for: 2.23Mt at 0.86%TNi. Bishi and Chikutiro (2022).
Woodridge & Erina	Discovery stage project with a Resource of 1.56Mt grading at 0.5% TNi declared. Bishi and Chikutiro (2022).
Knocknara – Inyeze	Early stage exploration project with significant Ni in soil anomaly.
Imbeza Nickel Project	Early stage exploration project.
Sword and Ingwenya	Early stage exploration project with limited soil geochemical survey and grab sampling indicating Nickel bearing sulphides
Wedza	Early stage exploration project investigated by two core holes drilled to 100m depth testing the trench anomaly showed high nickel values.
Mphoengs Nickel Prospect	Early stage exploration project. No information obtained.
Nanji and Tynan	Early stage exploration project considered to have similar geology to Trojan mine. Explored by Anglo American Cooperation, Blanket JICA and Mine. Nickel value of 0.4% in cores drilled up to 300m.
Bubi Gabbro	Early stage exploration project.

Table 11 Zimbabwe's nickel projects and their level of maturity

In Zimbabwe, nickel is currently mined from primary nickel sulphide deposits hosted in komatiites, and as a by-product of PGMs, mining from MSZ hosted in mafic and ultramafic rocks of the Great Dyke intrusion (Markwitz et al., 2010; Prendergast, 2003). Zimbabwe's komatiite-hosted primary nickel mineralization occurs at or near the base of lava flow units, especially in lava channels and sills. The main nickel sulphide minerals in these deposits are pyrrhotite, millerite, and pentlandite, with minor chalcopyrite. They have nickel to copper ratios of 12:1 to 20:1, such as at Shangani and Trojan deposits respectively (Markwitz et al., 2010). The deposits are found in both intrusive and extrusive environments. Deposits in intrusive environments are generally low-grade disseminated Ni-Cu sulphides in dykes, or sill like intrusions

Funded by
the European Union

(Prendergast, 2003). Deposits in extrusive environments have well-developed spinifex textures and flow breccias, they are low grade (0.4 to 0.6%), high tonnage massive sulphide mineralization, such as Hunters Road (31, 820t) and Shangani (243,230t) cumulative production (Markwitz et al., 2010). Komatiites hosted deposits extruded onto sedimentary environment are low grade, around 1%Ni with low tonnages.

Nickel sulphide deposits associated with the Great Dyke are mined predominantly for PGMs and are characterized by nickel grades of 0.24% and below and low tonnages ranging from 24.8 to 191.4 t cumulative nickel (Markwitz et al., 2010). Wilson and Tredoux (1990) gave an average Cu/Ni ratio of 8:1.

Zimbabwe has a number of low-grade high tonnage nickel sulphide deposits. These include Madziwa, a massive nickel sulphide deposit with an average nickel grade of 0.6% and Ni/Cu ratio from 5:1 to 3:1; Empress with Ni grades up to 0.4% and Ni/Cu ratios of 2:3, Shangani, Epoch, and Zinca currently out of production. The stalled reopening of these mines has been attributed to the prevailing Zimbabwe economic crisis (Markwitz et al., 2010). Trojan Mine, the only producing primary nickel sulphide deposit in the country, occurs within a pile of lensoidal bodies of serpentinised lavas. Cherts, banded iron formations (BIFs), graphitic shales, and felsic volcanics separate the serpentinite bodies from each other. Komatiitic and tholeiitic basalts form the footwall and hanging wall of the nickel bearing serpentinites. Nickel sulphide mineralization is found in two orebodies, the Main Orebody, and the Hanging Wall Orebody. The main ore body is massive locally also referred to as the footwall orebody. The Main Orebody is the largest and averages 250m long and 30m wide. There are other smaller ore bodies, such as the Trojan Hill, Cardiff East, and Cardiff Far East.

Three types of sulphide mineralization are found at Trojan Mine, namely: massive ore, near massive ore, and disseminated ore. The main sulphide minerals include pyrrhotite, pentlandite, and chalcopyrite, with pyrrhotite being the most abundant. Minor amount of millerite and pyrite are also present. The massive and near massive ores are situated towards the base of the lava units and are overlain by the disseminated ore (SRK Consulting, 2007). Zimbabwe nickel laterite deposits are located in the northern part of the great dyke. According to Mamina (2019), these deposits are yet to be quantified and commercially exploited. However, Dr. Martin Prendergast is reported to have delineated a resource of 20Mt at 1.5%Ni on the Horseshoe section of the Great Dyke between 2009 and 2010. As cited in Mamina (2019), information extracted from Prendergast's 2013 presentation, the Mvurwi laterite deposits have grades above 1% Ni in the sampled pits and fall into the low-grade class 0.6$ to 1.2% Ni on international markets. Information obtained from interviews during this study, the Mvurwi laterite deposits are reportedly being mined by a Chinese group.

Since nickel production from PGM dominant deposits has been dealt with under the PGM value chain, this section will focus on value chains of primary nickel sulphide value chains only. Bindura Nickel's Trojan mine is the only mine producing nickel from this deposit type in Zimbabwe now.

Trojan mine

At Trojan Mine, cathode nickel is recovered from pristine sulphide minerals selectively mined from the massive sulphide, near massive and disseminated sulphide orebodies by sublevel caving underground mining method. The orebodies are accessed from drives installed in the footwall on levels developed from

Funded by
the European Union

sub-level vertical shaft system. The blasted ore is hoisted to 7L, transported to the main shaft by locomotives, and hoisted to surface. The Trojan Mine shaft systems have an ore hoisting capacity of 130ktpm. Stopping operation is trackless using long-hole drill rigs and LHDs for all cleaning.

The ROM with a head grade of …is received into a 2.5kt live capacity silo ahead of primary jaw crushing, secondary and tertiary cone crushing to approximately 80% passing 12mm size. The crushed ore is delivered and milled in three primary ball mills and the combined discharge is pumped to two classifying cyclones. The cyclone underflow is returned to two of the primary ball mills operating in closed circuit. The cyclone overflow is dewatered and fed to the primary flotation plant. The Trojan Mine Concentrator incorporates two stages of flotation each comprising roughing and scavenging in low volume conventional cells with concentrate cleaning and re-cleaning in low volume conventional cells. In primary flotation, coarsely liberated and faster floating minerals are recovered at relatively coarse grind of 50% passing 75µm. Primary flotation tails are reground to approximately 65% passing 75µm ahead of secondary flotation, where finer and slower floating minerals are recovered to produce a flotation concentrate product with Ni grade of 9%Ni.

The flotation concentrate product thickened and filtered before transportation by road to the company owned Bindura Smelter and Refining (BSR) plant. At BSR, the moist flotation concentrate product received from TMC and third party tolling customers are blended and dried before being charged into the 15MW electric furnace for smelting to produce a smelter furnace product with a high sulphur and iron content. Furnace slag is tapped, granulated and removed to dumps. Furnace matte is periodically tapped into ladles for molten transfer to Pierce-Smith converters. Converter slag is recycled to the smelting furnace to produce a low sulphur converter matte, which is granulated ahead of transport to the refinery. Copper sulphide is recycled from the Refinery to the Smelter as required to ensure the required Ni/Cu ratio in leach alloy matte (SRK Consulting, 2007).

At the refinery, Bindura Nickel Corporation (BNC) converter matte is blended with third-party matte ahead of closed circuit ball milling. The ground leach alloy matte is leached at 80°C in acidic sulphate solution in a two-stage counter current atmospheric leach circuit comprising cementation and copper leach. This is followed by a third stage non-oxidizing pressure leach at approximately 140°C and 400kPa. Copper precipitates as copper sulphide under the pressure leach operating conditions and is recovered as a cake after filtration of the autoclave discharge. A separate autoclave operating under oxidizing conditions is used to remove iron and arsenic as an iron arsenate precipitate. This is drummed and disposed of in a secure bunker.

Impure nickel solution in the cementation thickener overflow contains cobalt in solution, which is precipitated with the addition of caustic soda and recovered as a cobalt hydroxide filter cake. Nickel catholyte after cobalt precipitation reports to the Nickel tank house where nickel is recovered by electro winning. The London Metal Exchange (LME) quality nickel cathodes are washed and cut into squares per customer requirement before being drummed and containerized for dispatch. BSR has a Smelter capacity of 160ktpa concentrate producing 22ktpa converter matte. The refinery capacity is 14,500tNi per year.

RioZim's Empress Nickel Refinery is currently under care and maintenance due to shortage of concentrate.

Funded by
the European Union

Zimbabwe nickel value chain summary

Zimbabwe nickel value chain is fully developed, with most segments of the value chain, exploration, extraction, concentration, smelting, converting, refining and production of nickel cathodes infrastructure available in the country. RioZim's Empress Nickel Refinery is currently under care and maintenance due to shortage of concentrate.

Tantalum value chain

Zimbabwe tantalum value chain

Tantalum in Zimbabwe is hosted in pegmatites found in three principal geographical areas namely: (i) northern Zimbabwe west of the Great Dyke, (ii) northeast Zimbabwe and Harare area, east of the Great Dyke, and (iii) the rest of the country. The majority of the tantalum produced in the country was from slags from the Kamativi mine. Tantalite-columbite production has also been recorded from a number of deposits including concentrates from a number other pegmatites and derived eluvial deposits (Bartholomew, 1990).

Tantalum production in Zimbabwe backdates to the 1930s. The country has 120 known tantalum deposits that have historically produced and 300 known occurrences (Bartholomew, 1990: Mlambo, 2011). Of the many tantalum-bearing minerals known, only microlite and tantalite-columbite are mined on a significant scale. The majority of the tantalum produced in the country was from slags from the Kamativi mine. Production of tantalite-columbite has been record from other pegmatites including concentrates from eluvial deposits formed from these pegmatites. Tantalite is produced from pegmatites together with other minerals such as beryl, tin, and lithium (Bartholomew, 1990). Table 12 shows Zimbabwe tantalum projects of significant economic potential with their levels of maturity.

PROJECT	LEVEL OF MATURITY	PROJECT	LEVEL OF MATURITY
AIRD/LUCKY DIP	Produced 1.05t 1975-84	**M AND D/ HILDA**	Produced 0.63t 1961-80
APEX	Produced 0.66t 1956-67	**MAUVE**	Produced 22.77t 1956-63
BERTAN	Produced 0.31t 1964	**MAYDAY**	Produced 0.14t 1954-61
BLUESTONE	Produced 0.68t 1981-82	**MAZOE VALLEY**	Produced 0.30t 1954-61
BREAM	Produced 0.86t 1980-81	**MISTRESS**	Produced 30.95t 1956-84
BUFROI	Produced 0.49t 1954-80	**MKANGA**	Produced 6.92t 1962-81
BURGESS	Produced 0.50t 1960-63	**MONDORO**	Produced 0.53t 1961-62
CARDEN	Produced 0.40t 1980-81	**NAMIKAZE**	Produced 0.63t 1967
CASE	Produced 0.47t 1978	**NEW DOLLAR**	Produced 0.05t 1970
CHIMBUMA	Produced 0.70t 1978	**PATRONAGE**	Produced 6.63t 1948-80
CHITANGA	Produced 0.65t 1969-70	**POPE**	Produced 0.45t 1979
DANNY BOY	Produced 0.18t 1961	**QUEEN'S GIFT**	Produced 3.27t 1966-68
FLORI'S LUCK		**RABBIT WARREN**	Produced 1.26t 1963-76
JACK'S LUCK	Produced 0.52t 1980-82	**SOWA**	Produced 0.01t 1981
JEREJOGA	Produced 1.43tt 1961-67	**SUSAMOYA**	Produced 0.75t 1957-64

Funded by
the European Union

JOKI	Produced 0.66t 1980-81	**SUTSKWE**	Produced 2.75t 1957-81
KAREN	Produced 0.40t 1968-69	**THORNEY**	Produced 1.22t 1962-63
KON	Produced 0.84t 1961-78	**TREB**	Produced 0.86t 1960-83
KONDO	Produced 3.78t 1958-81	**TYNAN**	Produced 0.62t 1967-82
KRAMAC	Produced 0.18t 1955	**VEE CEE**	Produced 0.22t 1969-70
LUCKY DIP	Produced 1.09t 1975-80	**VERDALE**	Produced 1.25t 1968-73
MA'S LUCK	Produced 0.08t 1968-80	**WANROO**	Produced 5.13t 1959-62
MAWALA	Produced 1.21t 1977-81	**WELCOME**	Produced 0.85t 1967-68
MTIRIKATI	Produced 0.16t 1959	**ALPHA**	Produced 0.52t 1954-75
NYANGOMA	Produced 0.09t 1971-81	**BEBE/STAR**	Produced 1.16t 1955-69
PHILLIP	Produced 1.10t 1961-81	**BEPE**	Produced 26.55t 1955-69
PICARDE	Produced 0.48t 1958-73	**BIKITA**	Produced 156.77t 1931-59
RITA	Produced 0.36t 1954-82	**CORUNDUM**	Produced 4.54t 1954-66
RUTANSA	Produced 0.21t 1968	**DELHI**	Produced 3.23t 1947-67
SARA	Produced 0.11t 1973	**DIRK**	Produced 0.36t 1967-82
STAR TURN	Produced 3.31t 1957-78	**EBONITE**	Produced 11.35t 1926-55
TERESA	Produced 1980	**GOD VALLEY**	Produced 0.86t 1964-68
THE MINISTER/ O'BET	Produced 2.17tt 1971-82	**GWAAI**	Produced 34.57t 1954-81
WAJETSI	Produced 0.43t 1980-81	**KALINDA**	Produced 0.02t 1967
WEZUA LILLINGTON	Produced 0.15t 1954-80	**KAMATIU**	Produced 559.08t 1959-84
WEZUVA JMP	Produced 2.82t 1979-83	**KAPATA**	Produced 3.88t 1953-77
BENSON	Produced 167.03t 1954-83	**LAST CHANCE**	Produced 1.37t 1952-52
BERTELITE	Produced 0.33t 1961-84	**LITTLE EDWARD**	Produced 0.99t 1959-67
BERYL ROSE	Produced 26.76t 1961-84	**LUCKY**	Produced 0.58t 1953
BESTER'S LUCK	Produced 0.09t 1970	**LUTOPE**	Produced 7.81t 1954-79
BIRTHDAY GIFTBOMB	Produced 6.68t 1957-80	**MONDEOR**	Produced 1.28t 1961
BRIDGE/ FLORIDE	Produced 0.16t 1966	**MWERIHARI**	Produced 1.45t 1960-68
BUSH RIDGE	Produced 8.76t 1962-81	**NEL'S LUCK**	Produced 7.76t 1962-69
CHRISSIE	Produced 0.10t 1967-82	**NOMIT WEST**	Produced 0.34t 1955
CONSOLATION	Produced 0.23t 1961-62	**PEPE**	Produced 0.25t 1967
DEVIL	Produced 0.15t 1960-61	**PORTREE**	Produced 21.37t 1956-81
DIZZY	Produced 0.35t 1954-61	**PYTHON EGGS**	Produced 3.37t 1954-57
EAGLE	Produced 4.71t 1967-69	**RUB**	Produced 0.22t 1961-68
FRESH START	Produced 0.09t 1955	**SABI STAR**	Produced 0.64t 1962-68
GOD'S GIFT	Produced 2.99t 1960-84	**SERIMA**	Produced 0.69t 1955-57
GOOD DAYS	Produced 2.14t 1956-71	**SMOKY**	Produced 9.12t 1965-81
GUARDIAN	Produced 0.31t 1968-69	**SPECIAL GRANT 208/223**	Produced 0.50t 1960-63

Funded by
the European Union

GUINEY BONE	Produced 0.03t 1960	**SPECIAL GRANT 212**	Produced 0.53t 1961
HOTSPUR	Produced 0.83t 1955-68	**SPECIAL GRANT 213**	Produced 0.36t 1961-70
JOKING	Produced 5.40t 1962-63	**SPECIAL GRANT 317/349**	Produced 0.62t 1966-68
JORDY WITT	Produced 0.25t 1957-69	**SYDKOM**	Produced 0.14t 1967
LOCHNESS	Produced 1.78t 1962-67	**WAGON WHEEL**	Produced 1.27t 1967-68
MABELLE	Produced 5.24t 1968-82	**WOLF**	Produced 8.15 1961-68

Table 12 Zimbabwe's tantalium projects and their level of maturity

In Zimbabwe, tantalum is recovered in the form of tantalite, tantalite-columbite from pegmatites mainly mined by open pit mining methods. Tantalite is produced mainly as a by-product of lithium mining. Concentration process multi-stage crushing of the ROM ahead of milling. At Sabi Star mine, dense media separation technique is used to separate tantalite from the spodumene concentrate. At Arcadia, tantalite is recovered in a dedicated spiral circuit placed in the flotation tailings stream. The rough tantalite is upgraded to a saleable product containing approximately 25% Ta2O5 by the use of conventional gravity concentration methods and magnetic separation.

Zimbabwe tantalum value chain summary

Zimbabwe's tantalum value chain is restricted to the upstream segment of the value chain. Exploration, extraction, and concentration stages of the value chain are developed. Tantalum is sold as Ta205 concentrate.

Niobium value chain

Zimbabwe niobium value chain

In Zimbabwe, niobium is found with tantalum in three principal minerals: columbite-tantalite (Coltan), microlite, and simpsonite in pegmatites. Columbite (Nb) and tantalite (Ta) are end members of isomorphous solid solution series. If the mineral is Fe-rich, it is referred to as ferrotantalite and manganotantalite, if manganese is more than iron in the solid solution. In the columbite-tantalite, the mineral is called tantalite if tantalum (Ta_2O_5) content is greater than 86% and columbite if niobium (Nb_2O_5) is greater than 78%.

Mineralized pegmatites include Bepe Hills, Bikita, Harare-Shamva, and Makati-Makaha pegmatites, emplaced into Archaean Shield (+2.65 Ga), and Palaeoproterozoic (2.0-1.8 Ga), these include the Kamativi and Miami Pegmatites emplaced in Palaeoproterozoic terrain (Barber, 20216). The Kamativi Pegmatite Field pegmatites are predominantly emplaced in Palaeoproterozoic age garnetiferous mica schists during late phase Kibaran Orogeny. The pegmatites are not truly zoned but display three distinct mineralogical phases: potash feldspar, albite-rich, and muscovite-quartz phases. The pegmatites have been divided into four groups: cassiterite bearing, tourmaline mineralized, non-mineralized tourmaline bearing, and quartz pegmatites. Cassiterite-bearing pegmatites predominate (Barber, 2016).The Miami Pegmatite Field is predominantly emplaced in garnetiferous mica schists and metapelitic gneisses of the Magondi Mobile Belt. The pegmatites have been divided into three groups: the uneconomic and barren, economic mica-bearing and economic beryl-bearing pegmatites. In addition to beryl, the economic beryl-bearing

Funded by
the European Union

pegmatites have also been exploited for niobium-rich coltan, small quantities of amblygonite, cassiterite, and magnetite. The Bepe Hills Pegmatite Field situated approximately 70km west southwest of Mutare, contains numerous, commonly tabular, irregular shaped pegmatites emplaced in Archaean aged strata Mutare Greenstone Belt. These pegmatites have been exploited for beryl, cassiterite, coltan, microlite, and lithium minerals.

The Bikita Pegmatite field pegmatites are characterized by zoning and are emplaced sub-parallel to the Masvingo Greenstone Belt. A paper by Masimirembwa and Harawa (2019) states that "Dasent (1981) divided the pegmatites into soda-rich (Na-K) and potash-rich (K-Na). The pegmatites are mined for lithium and beryl minerals, with cassiterite, coltan, and microlite recovered by-products. The Harare-Shamva Pegmatite Field pegmatites are late-Archaean age emplaced in meta-basaltic, gabbroic and gneissic rocks close to the Chinamora and Murehwa Batholiths. A number of mines, albeit small, have produced microlite. The Makati-Makaha Pegmatite Field pegmatites are emplaced in the Makati-Makaha Greenstone Belt.

Niobium-containing minerals columbite-tantalite, microlite, and simpsonite are recovered as by-products of mainly lithium mined by open pit mining method. The ROM undergoes a series of crushing, milling, and flotation to produce a tantalite concentrate containing undeclared amounts of niobium that is shipped to market.

Zimbabwe niobium value chain summary

The niobium value chain in Zimbabwe is poorly developed. Niobium is produced in the form of tantalite concentrate and its value is obscured. This is despite the fact that most lithium mining companies declare the mineral in their mineral reserve and resources.

Magnesium value chain

Zimbabwe magnesium value chain

Magnesium in Zimbabwe is found in magnesite. The country has 11 known magnesite deposits. Table 13 is a list of the magnesite deposits and their level of maturity. The Kadoma Magnesite mine on Farm Barton in Kadoma District, Mashonaland West Province, is the largest and only producing mine in the country. The deposit is hosted in volcano-sedimentary rocks and lavas and is thought to have formed from magnesium alteration of dolomite. Several other deposits are also known including Mat Mine, Calc Deposit and Bukwa Magnesite (Bartholomew, 1990). There is no production of magnesium metal in Zimbabwe. Magnesite is processed to produce a variety of products specific to customer requirements. The value chain consists of exploration, mining, separation, and calcining.

PROJECT	LEVEL OF MATURITY
Barton Farm Mine (Kadoma Magnesite Mine)	Producing mine with an annual capacity of (868024t was produced between 1932-84)
Bukwa Magnesite mine	
CALC	Historical operation. Produced 13739t between 1968-70)

Funded by
the European Union

Freedom	Historical project that produced 351t in 1943
Gwati (Chishanya Phosphate)	Historical project that produced 205t between 1981-82
Krantz	Historical project that produced 98t between 1949-61
Mat	No production prospect
Mwele	273t 1943-62
Pande	Historical project that produced 836308t from 1964-84
PYE	No production prospect
Wojele	Historical project that produced 186t between 1940-47

Table 13 Zimbabwe Magnesite Projects with level of maturity

Magnesite is extracted by underground mining method. The ROM is loaded into coco pans and is hoisted to surface, and trammed to the on-site crusher, where it is crushed to produce fine raw magnesite ore product ahead of thermal separation in the kiln. The fine raw magnesite ore is sent into a kiln for calcination at a temperature of 700-800°C for 1 hour to produce a brittle, porous, and low compressive strength. Gangue minerals such as talc and dolomite are hardened, ahead of selective crushing and screening to separate the magnesium oxide powder from the gangue-containing mineral particles and produce a caustic magnesia final product sold to local farmers for animal feed, lime for agricultural, chemical industries, construction, chewing gum, and other manufacturing uses.

Zimbabwe magnesium value chain summary

The magnesium value chain in Zimbabwe is not fully developed. The magnesite ore is processed to produce caustic magnesia used in different industries.

Tungsten value chain

Zimbabwe tungsten value chain

Zimbabwe has a total of 355 known tungsten deposits and occurrences. Tungsten mineralization occurs in three different geological settings namely, Archaean greenstone belts, Proterozoic Zambezi Metamorphic Belt, and those associated with late Karoo granitic activity. The majority of tungsten production in the country has come from greenstone belts where scheelite is produced as a by-product of gold mining. In the Zambezi Metamorphic Belt, tungsten has been mined from two sectors where it is found in wolframite-bearing quartz veins. Production Nearly all the production in western Hwange sector has come from the R.H.A mine. In the Hwange sector to the east mineralization is concentrated in the Honey Wolframite Belt east of the Karoi and also occurs in higher grade Piriwiri gneisses south-east of Kariba (Bartholomew, 1990). The latest mineralization is found in veins associated with a late Karoo granophyre intrusion in the southeast of the country where veins contain both scheelite and wolframite, as well as abundant sulphide minerals. Table 12 is a list of some of the projects and their level of maturity.

Local tungsten production is in the form of mineral concentrates grading a minimum of 65% tungstic oxide (Bartholomew, 1990). RHA Tungsten mine is the only primary tungsten deposit producing in the country. Tungsten is produced as a by-product of mining of other minerals at Turk, Muriel, Dollar Tantalite and Dorowa mines. Tungsten processing flowsheets from these operations are not available. Zimbabwe

Funded by
the European Union

tungsten processing in this report is based on the RHA Tungsten Mine value chain. The primary tungsten mineral of economic interest is wolframite ((Fe, Mn) WO4).

Name Project	Level of Maturity
RHA Tungsten Mine	Commercial production was planned to start in 2022. The project has a code-compliant resource of 22.14 million tonnes at 2.45kg per tonne in both the underground and open pit operations. The processing plant has a capacity of 40,000tpm (Premier Africa Mineral, 2016).
Dorowa Mine	Producing mine. Scheelite is produced as a by-product of phosphate rock mining.
Turk Mine	In commercial production: Wolframite is produced as a by-product of gold mining.
Muriel Mine	In commercial production: Wolframite is produced as a by-product of gold mining.
Sandawana Mine	Emeralds co-produced with tantalite: Tungsten, beryl, mica, and gold are known to exist.
Dollar Tantalite Mine	Tungsten is co-produced with tantalite.

Table 14 List of Tungsten Project and their level of Maturity

Zimbabwe tungsten is recovered from scheelite and wolframite minerals mined by both open pit and underground mining methods. Drilling and blasting are employed to extract the ore rock. The run of mine ore with a head grade of 3.6% WO_3 (Tungsten oxide), is crushed and jigged to produce a coarse concentrate assaying about 62.7% WO_3. The 62.7% WO_3 is further ground ahead of spiral concentration to produce a concentrate product with a grade of 65.7% WO_3.

Zimbabwe tungsten value chain summary

Tungsten value chains in Zimbabwe are restricted to the upstream segment of the value chain comprising exploration, mining, and concentration. Tungsten extraction and purification (refining) stages are not happening in Zimbabwe. Tungsten extraction involves the roasting and chemical treatment of the 65% WO3 concentrate product to remove sulphides and arsenides to produce a higher value intermediate compound, ammonium paratungstate (APT) product. Tungsten refining involves the chemical treatment of the APT product to produce tungsten to produce most pure tungsten crystals called ATP, which is further treated to produce different tungsten powders.

Beryllium value chain

Zimbabwe Beryllium value chain

Beryllium value chain comprise exploration, mining, separation, smelting, solvent extraction, refining, and product manufacture. These activities are not happening in the country at the moment.

Antimony value chain

Zimbabwe Antimony value chain

Funded by
the European Union

Antimony deposits in Zimbabwe are hydrothermal-type deposits hosted in quartz-carbonate veins in greenstone belts. The Midlands Greenstone Belt, one of the largest gold districts in Zimbabwe and, on a world scale, represents a major province of vein and shear-zone-hosted gold and gold-antimony mineralization. In the Kwekwe district alone, a total of 188Mt of gold and 4,500t of stibnite concentrate has been produced from 137 mines (Bartholomew, 1990: Du Toit, 1998). The Kwekwe district comprises the central part of the Archaean Midlands greenstone belt, which hosts massive antimony mineralization. Stibnite-gold mineralization is a late stage hydrothermal event. Mineralization occurs in the form of polymetallic veins and alteration zones, with massive stibnite mineralization and high gold occurring within brittle deformed veins, and dyke like the one reefs associated with native gold, sphalerite, and pyrite. Hydrothermal alteration includes sericitisation, carbonatisation, and propylitisation (Buchholz et al., 2007). Table 15 shows Antimony projects and level of maturity.

Project	Level of Maturity
Jojo Mine	Producing Gold and Antimony Resource of 487,442t at 6.06g/t Au, and 6% Sb. Owned by a Chinese group that acquired the property from Homestake Mining Company. Mining underground and stockpiling Au/Sb ore while building Carbon In Pulp (CIP) (2000tpd), and Flotation Plant (500tpd) on site
Monte Christo Mine	Producing Gold and Antimony Resource of 754,903t at 3.7g/t Au, and 4.5%Sb. Mining and stockpiling.
Anzac Mine	Producing Gold and Antimony Resource 450,000t at 7g/t Au, and 8%Sb. Underground mining and processing for gold and antimony flotation and roasting methods.
Munyati Antimony Mine	Producing and Feeding the ore to the Sebakwe Flotation Plant.
Dalling Mine	Operational: Underground gold 2.6g/t and 12% Sb. Processing ore at Ivanhoe Milling Centre doing about 4t of concentrate per day (100tpm concentrate). Leaching gold and stockpiling Sb concentrates.
Bell Riverlea	Producing but no data provided. Mining gold and antimony.
Newtron King Mine	Producing

Table 15 Antimony project and level of maturity

Antimony in Zimbabwe is recovered from stibnite mined by underground mining methods from quartz carbonate hydrothermal deposits in greenstone belts. The ore is hoisted to surface and trammed to plant for processing. The majority of the antimony is at the moment stockpiled while the beneficiation facilities are being put in place. The ROM is crushed before being fed into leaching pads to remove the gold. The remaining antimony concentrate is stockpiled.

Funded by
the European Union

Zimbabwe antimony value chain summary

Only the exploration and mining stages of the upstream segment of the antimony value chain are fully developed in Zimbabwe.

Manganese value chain

Zimbabwe manganese value chain

Manganese deposits in Zimbabwe are small, scattered, and not sufficient to meet demand. Manganese has also been produced as a byproduct of iron ore mining (Bartholomew, 1990). According to the Minerals Marketing Corporation of Zimbabwe, Randstad Mining, is the only company exporting manganese ore in the country. The manganese is mined in the Dotito–Rushinga-Nyamapanda area. However, from telephonic interviews carried with some operators on the ground, Randstad Mining is buying manganese ore from a number of artisanal miners working different claims. Manganese deposits in Dotito-Rushinga-Nyamapanda area are stratabound and stratiform hosted in high-grade metamorphic rocks of the Rushinga Group. Historical grab samples have returned impressive grades of up to 53% Mn (Metals of Africa, 2012).

Manganese is ore recovered by on surface excavation of the orebody using hired machinery and times by hand. Ore concentration is achieved through visual separation of ore and waste rock before the manganese ore is sold to customers on site.

Manganese value chain summary

Zimbabwe manganese value chain is poorly developed. In the upstream segment, it is difficult find projects in exploration stage, while there is extraction, albeit, at artisanal level, it is difficult pinpoint the real project sponsors.

Recycling in Zimbabwe

Recycling in Zimbabwe is dominated by the production of steel products from scrap metals. Naisonale Investments, which employs about 150 workers, recycles scrap to supply steel products such as beams to the domestic construction sector. At peak output, the company produces 30 to 40 tonnes of steel per day. Steel is considered by the government to be a critical industry, so companies such as Naisonale have been exempted from the planned power outages, which have crippled other industries in the country.

The scrap includes parts from haulage trucks and railways, such as tracks and train components collected from various centres throughout the country. A tonne of scrap metal sells for US$150, but dealers can get up to US$300 depending on the day's market price.

The ECRMs recovered from various end-of-life components include platinum, palladium recovered together with gold, and silver from electronic waste and catalytic converters by Eco-Tech Recycling. The company also recycles copper, aluminum, and steel from various scrap materials. Zim Battery Recycling recycles lead-acid batteries and recovers lead, sulphuric acid, and plastic. The company also produces new batteries from recycled materials. Green Energy Solutions recycles lithium-ion batteries and recovers

Funded by
the European Union

lithium, cobalt, nickel, and manganese. It also produces new batteries and solar panels from recycled materials. ZimRecycle recovers lithium, cobalt, nickel, and manganese from used batteries and converts them into high-quality products for the battery industry. The company also provides collection and transportation services for battery waste across the country. E-Waste Zimbabwe recycles electronic waste, such as computers, phones, TVs, and printers, and extracts valuable metals, such as gold, silver, copper, and palladium. E-Waste Zimbabwe also offers data destruction and refurbishment services for electronic devices. CatCo, recycles catalytic converters from vehicles and recovers platinum group metals such as platinum, and rhodium. CatCo also sells new and used catalytic converters and provides testing and certification for vehicle emissions. Mine Rec, specializes recycling mining waste, such as tailings and slag, and recovers rare earth elements such as neodymium, dysprosium, and terbium. Mine Rec also provides environmental remediation services.

Lithium Recycling in Zimbabwe

Green Energy Solutions and ZimRecycle are involved in the recycling of lithium in Zimbabwe. Green Energy Solutions recycles lithium-ion batteries and recovers lithium, cobalt, nickel, and manganese. It also produces new batteries and solar panels from recycled materials. ZimRecycle recovers lithium, cobalt, nickel, and manganese from used batteries and converts them into high-quality products for the battery industry. ZIMRecycle also provides collection and transportation services for battery waste throughout the country.

PGM recycling in Zimbabwe

Three companies are involved in PGMs recycling in Zimbabwe. Eco-Tech recovers precious metals, such as gold, silver, platinum, and palladium, from electronic waste and catalytic converters. It also recycles copper, aluminum, and steel from various scrap materials. E-Waste, recycles electronic waste, such as computers, phones, TVs, and printers, and extracts valuable metals, such as gold, silver, copper, and palladium. E-Waste Zimbabwe also offers data destruction and refurbishment services for electronic devices. CatCo recycles catalytic converters from vehicles and recovers PGMs, such as platinum, palladium, and rhodium. CatCo also sells new and used catalytic converters and provides testing and certification services for vehicle emissions. Production statistics of these operations have not yet been established.

Nickel Recycling in Zimbabwe

Green Energy Solutions recycles lithium-ion batteries and recovers lithium, cobalt, nickel, and manganese. It also produces new batteries and solar panels from recycled materials. ZimRecycle recovers lithium, cobalt, nickel, and manganese from used batteries and converts them into high-quality products for the battery industry. ZimRecycle also provides collection and transportation services for battery waste across the country.

Tantalum Recycling in Zimbabwe

Tantalum can be recovered from waste of electrical and electronic equipment. Currently, there is no known company recycling tantalum in Zimbabwe.

Funded by
the European Union

Niobium Recycling in Zimbabwe

There is currently no known niobium recycling in Zimbabwe.

Magnesium recycling in Zimbabwe

Considered the most eco-friendly and sustainable metal, magnesium can be fully recycled, and it dissolves naturally, leaving no trace. Magnesium and its alloys can be fully recycled back into products retaining the same chemical, physical, and mechanical attributes as primary metal. Magnesium recycling is energy efficient, it uses only 5% of the energy required to produce primary magnesium alloys. There is no magnesium recycling in Zimbabwe at present.

Tungsten Recycling in Zimbabwe

Currently, there is no known company recovering tungsten from either tungsten metal scrap or recycling of tungsten tailings. Enhanced gravity separation, wet high-intensity magnetic separation, and flotation have been reported to be successful in reprocessing tungsten tailings. Bioleaching can assist with removing some toxic elements. Tungsten metal scrap is at present the only secondary source for tungsten.

Antimony Recycling

The main end-of-life recycling option for antimony is from spent lead-acid batteries, where antimony is directly recovered as a lead-antimony alloy. Zim battery recycling recycles lead-acid batteries and recovers lead, sulphuric acid, and plastic. It also produces new batteries from recycled materials.

Manganese recycling in Zimbabwe

Manganese is recycled primarily within the scrap of iron and steel, with a minor portion also being recycled within aluminum used in beverage cans, and used car batteries. Manganese recycling is therefore accounted for in iron and steel recycling. In Zimbabwe, Eco-Tech Recycling recovers manganese from steel. ZimRecycle recovers manganese, together with lithium, cobalt, and nickel from used batteries and converts them into high-quality products for the battery industry. ZimRecycle also provides collection and transportation services for battery waste across the country.

2.1.2 Existing ESG indicators

Existing key ESG indicators that can be used to evaluate the performance of CRM mining in Zimbabwe are:

Environmental impact: Mining companies are expected to comply with environmental regulations and standards, and implement best practices for environmental management and restoration.

- **Social responsibility contribution** to the social well-being of its stakeholders, such as employees, local communities, customers and suppliers is paramount in Zimbabwe. Companies working in Zimbabwe are required by law to respect human rights, labor rights, health and safety standards as well as cultural diversity. Mining companies already working in Zimbabwe have demonstrated social responsibility and engaged in dialogue and consultation with its stakeholders. The platinum

Funded by
the European Union

mining companies have supported social development initiatives such as education, health care and infrastructure.

- **Governance and ethics**: The Zimbabwean government places emphasis on mining companies' governance structure, policies and practices. The mining company should have a clear vision, mission and values, and adhere to ethical principles such as honesty, integrity and accountability.
- **Economic performance**: Besides paying taxes, royalties and fees to the government, the Zimbabwean government NDS1 strategy aims to accelerate beneficiation and value addition and move away from exports of raw and semi-processed minerals and thereby mining company are expected to invest in innovation, technology and skills development, and create employment opportunities for local people.
- **CRM stewardship:** Mining companies working in Zimbabwe are expected to manage their CRM resources efficiently and responsibly. CRM are essential for many high-tech applications such as renewable energy, electric vehicles and digital devices. The mining company should ensure that its CRM extraction, processing and supply chain are secure, reliable and sustainable. The mining company should also promote the circular economy of CRM by reducing waste, increasing recycling and reusing materials.

2.1.3 Status of economic links between the formal and informal sectors

Economic linkages between formal and informal sectors are already established with tribute mining being noticeable in the mining sector. Opportunities for informal businesses and individuals to contribute to and benefit from the mineral industry by supplying necessary resources, equipment, expertise, and support services exists in the Zimbabwean minerals industry. Figure 9 presents the numerous opportunities along the mineral value chain in Zimbabwe that can be used for linkages. Throughout the different segments of the mineral value chain, some connections and linkages already exist where informal entities and individuals provide goods and services to the formal mineral sector. The formal sectors also provides equipment and work spaces to the informal sector. However linkages with other actors in the other industries such as banks, brokers, transporters, health service providers and regulators can still be improved. NDS1 which aims to accelerate beneficiation and value addition and move away from exports of raw and semi-processed minerals is expected to strengthen linkages along the mineral value chain as well as between informal and formal sector.

2.2. Identification of the bottlenecks along the value chain

To identify the bottlenecks of the critical raw materials value chain in Zimbabwe, this case study summarized the Fraser Institute 2022 survey, the World Bank Logistics Performance Index (LPI) the World Bank Worldwide Governance Indicators (WGI) and ZEPARU reports (ZEPARU 2020).

According to the 2022 Fraser Institute studies, considering both mineral and policy factors, Zimbabwe was one of the least attractive jurisdictions in the world for mining investment. The institute's annual survey of mining companies assesses how mineral endowments and public policy factors such as taxation and regulatory uncertainty affect exploration investment. The survey also includes an analysis of permit times for mining exploration, which is another potential bottleneck for mining projects. The 2022 survey results

Funded by
the European Union

are based on the responses of 290 individuals from 84 jurisdictions around the world. According to this report some of the policy factors that discourage mining investment in Zimbabwe are corruption, political instability, legal system, infrastructure, and labor regulations.

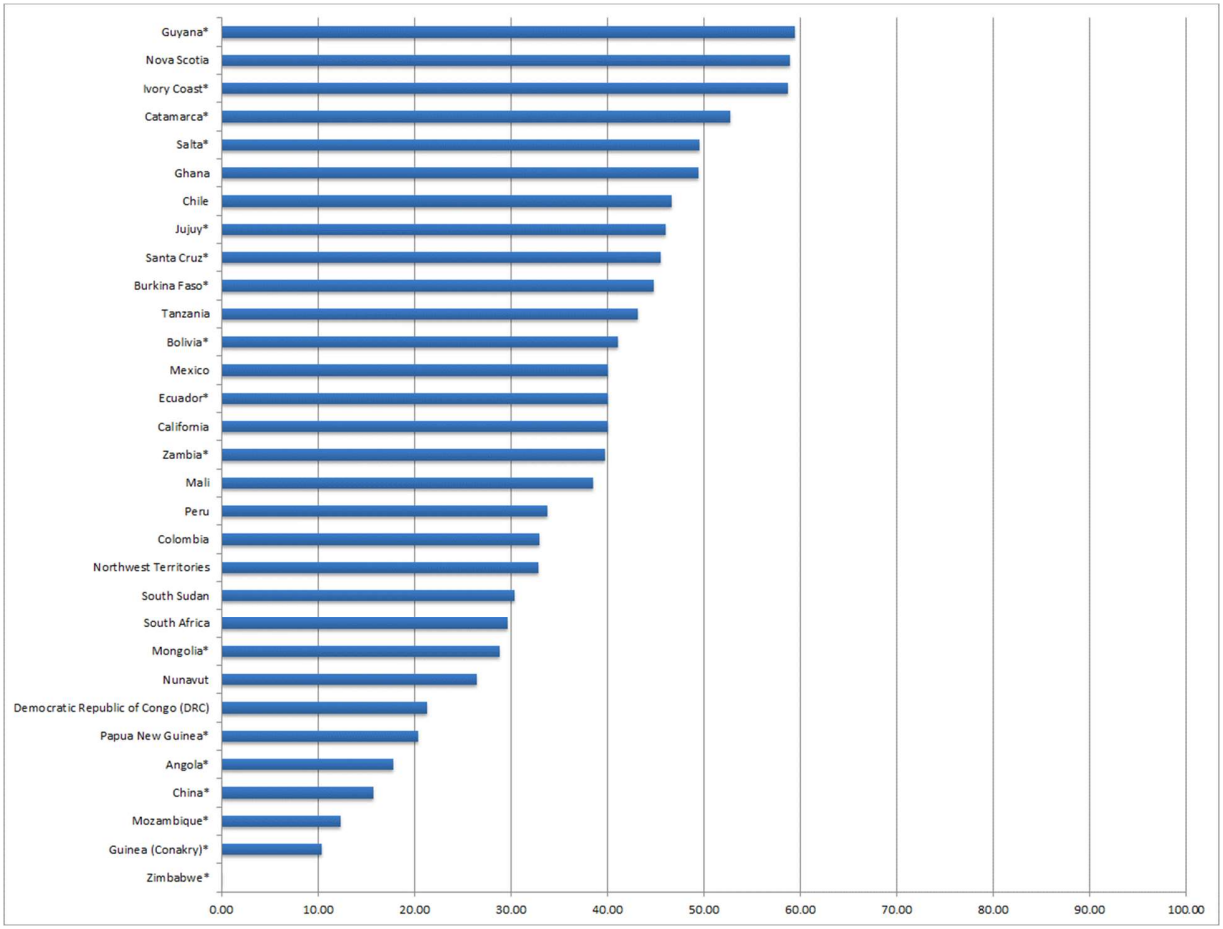


Figure 12 Policy perception index by Fraser institute showing the Zimbabwean position (2022) [10]

The Logistics Performance Index (LPI) is a tool created by the World Bank to measure the efficiency and quality of trade logistics and transport-related infrastructure in different countries. The LPI 2023 covers 139 countries and uses six indicators: customs, infrastructure, international shipments, logistics competence, tracking and tracing, and timeliness. The LPI 2023 report, ranks Zimbabwe 97th out of 139 countries, with an overall score of 2.5 out of 5. Zimbabwe performs best on the timeliness indicator (ranked 87th with a score of 2.8) and worst on the logistics competence indicator (ranked 119th with a score of 2.3). Zimbabwe's LPI score has improved slightly from 2.4 in 2018, but still lags behind the average of Sub-Saharan Africa (2.6) and lower middle income countries (2.7). The report suggests that Zimbabwe needs to address the challenges and opportunities it faces in its trade logistics performance, such as

[10] Accessed at annual-survey-of-mining-companies-2022-figures-and-tables.xlsx (live.com)

Funded by
the European Union

improving its infrastructure, facilitating trade procedures, enhancing its logistics services, and ensuring supply chain security and resilience.

According to the Worldwide Governance Indicators (WGI) by the World Bank, Zimbabwe ranks below the average of sub-Saharan Africa and the world in all these dimensions. The WGI are based on data from various sources, such as surveys, think tanks, NGOs, international organizations, and private sector firms. The WGI show that Zimbabwe has experienced a decline in governance quality since 1996, with some slight improvements in recent years. The WGI suggest that improving governance is crucial for achieving better development outcomes and attracting investment.

A summary of the bottlenecks according to WGI for Zimbabwe is:

- Voice and Accountability: This dimension measures the extent to which citizens can participate in selecting their government, as well as the freedom of expression, association, and media. Zimbabwe scored -1.23 in 2020, ranking at the 14th percentile among all countries. This indicates a low level of voice and accountability in Zimbabwe, which may undermine the legitimacy and responsiveness of the government.
- Political Stability and Absence of Violence: This dimension measures the likelihood of political instability and violence, such as terrorism, civil war, coups, or riots. Zimbabwe scored -1.64 in 2020, ranking at the 7th percentile among all countries. This indicates a high risk of political instability and violence in Zimbabwe, which may disrupt social order and economic activity.
- Government Effectiveness: This dimension measures the quality of public services, the capacity of civil servants, the independence of public institutions from political pressures, and the credibility of policy commitments. Zimbabwe scored -1.32 in 2020, ranking at the 9th percentile among all countries. This indicates a low level of government effectiveness in Zimbabwe, which may affect the delivery and quality of public goods and services.
- Regulatory Quality: This dimension measures the ability of the government to formulate and implement sound policies and regulations that promote private sector development. Zimbabwe scored -1.38 in 2020, ranking at the 8th percentile among all countries. This indicates a low level of regulatory quality in Zimbabwe, which may hinder the growth and competitiveness of the private sector.
- Rule of Law: This dimension measures the extent to which agents have confidence in and abide by the rules of society, such as property rights, contract enforcement, police, courts, and crime. Zimbabwe scored -1.51 in 2020, ranking at the 6th percentile among all countries. This indicates a low level of rule of law in Zimbabwe, which may erode trust and security among citizens and businesses.
- Control of Corruption: This dimension measures the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as the capture of the state by elites or interest groups. Zimbabwe scored -1.36 in 2020, ranking at the 8th percentile among all countries. This indicates a high level of corruption in Zimbabwe, which may reduce efficiency and equity in resource allocation and undermine public integrity.

Funded by
the European Union

According to Zimbabwe Economic Policy and Research Unit (ZEPARU), Companies and authorities in Zimbabwe suffer from inadequate infrastructure, low revenue collection, weak governance and regulatory frameworks, and limited capacity to manage and maintain services. These bottlenecks affect the provision of water, sanitation, waste management, roads, and other public goods that are essential for growth and sustainability. The report recommends strengthening the legal and institutional framework for local authorities, enhancing their financial management and accountability, improving their infrastructure planning and maintenance, and promoting citizen participation and feedback. There are several bottlenecks that hinder the optimal utilization and value addition of CRM resources in Zimbabwe according to the above reports.

2.2.1 List of the main bottlenecks and the links between them

- Lack of adequate infrastructure and logistics: The mining sector in Zimbabwe faces challenges such as poor road and rail networks, unreliable power supply, limited water availability and high transportation costs. These factors increase the operational costs and reduce the competitiveness of the sector. Moreover, they limit the access to domestic and international markets, as well as to downstream industries that can process and transform the raw materials into higher-value products.
- Lack of investment and financing: The mining sector in Zimbabwe suffers from a lack of investment and financing, both from domestic and foreign sources. This is due to several reasons, such as political instability, policy uncertainty, corruption, sanctions, currency volatility and high inflation. These factors create a risky and unfavorable business environment that discourages investors and financiers from supporting the sector. As a result, the sector lacks the capital and technology needed to explore, extract, process and upgrade the raw materials.
- Lack of human capital and skills: The mining sector in Zimbabwe faces a shortage of qualified and skilled personnel, both at the technical and managerial levels. This is mainly due to brain drain, poor working conditions and low wages. These factors affect the productivity and efficiency of the sector, as well as its ability to innovate and adopt best practices. Moreover, they limit the capacity of the sector to comply with environmental and social standards, as well as to engage with local communities and stakeholders.
- Lack of governance and regulation: The mining sector in Zimbabwe operates under a weak and fragmented governance and regulatory framework. This is due to several reasons, such as lack of coordination among different ministries and agencies, lack of transparency and accountability, lack of enforcement and compliance mechanisms, lack of stakeholder participation and consultation, lack of data and information systems. These factors affect the quality and sustainability of the sector, as well as its contribution to the national development goals. Moreover, they expose the sector to risks such as illegal mining, smuggling, conflict, human rights violations and environmental degradation.

- High costs of production and low competitiveness, due to factors such as outdated technology, low productivity, high taxes and tariffs, and exchange rate volatility.

Funded by
the European Union

- Weak linkages and integration among different actors in the value chain, such as miners, processors, manufacturers and exporters.
- Low levels of value addition and beneficiation, which result in exporting raw materials at low prices and importing finished products at high costs.
- Environmental and social challenges, such as land degradation, pollution, deforestation, human rights violations, and conflicts over natural resources.

Funded by
the European Union

3. Investment/financing prospects for ECRM projects in the Zimbabwe

3.1. Fiscal, legislative and regulatory context for in-country financings

Revenue collection and allocation

Government's concern over the years has been that revenue collection from the mining sector is sub-optimal, compromised by loopholes in income tax framework; lack of full disclosure on mining data that undermines revenue forecasting and illicit financial flows characterized by transfer pricing and trade miss-invoicing. In response to these concerns Government has been reviewing the mining fiscal regime particularly license fees and royalties through the several Budget Statements and Finance Acts a view to enhance the balance between revenue generation and attraction of investment into the mining sector. The reviews have also focused on mining eliminating duplication in the collection of levies to improve efficiency in revenue collection, addressing transfer pricing and thin capitalization where high-geared mining companies enjoy tax relief on interest charges.

The outdated 1961 Mines and Minerals Act [Chapter 21:05] which is now being amended is still the main law that governs the exploitation of mineral resources in Zimbabwe. Section 244 (1) states that "...the miner of a registered mining location shall pay royalty on all minerals or mineral-bearing products…" Section 245 further states that the rate of royalty payable in terms of section 244 shall be fixed by the House of Assembly in the Schedule to Chapter VII of the Finance Act [Chapter 23:04].

This New Mines and Minerals Bill seeks to replace the Mines and Minerals Act [Chapter 21:05] to achieve the following main objects:

- To change the composition of the Mining Affairs Board and to clarify and extend its function;
- To formalize the switch in title from "mining commissioner" to "Provincial Mining Director" (PMD): this is the official primarily responsible for administering the Mines and Minerals Act at the local level;
- To establish the Mining Cadastre Register and Registry, and to reduce the classes of Mining Titles to three only; consistently with the introduction of the Mining Cadastre Register, which will ensure uniformity and simplicity of mining titles, the pegging of secondary reefs and the holding of extra-lateral rights are abolished;
- To regulate the activities of prospectors more closely, and to confine their activities to specific areas defined by grids;
- To remove the distinction between precious metal and base metal claims, and to abolish the extra-lateral rights which holders of precious metal claims enjoy at present;
- To provide for mining title to be granted in the form of a mining lease, where the title extends over four or more contiguous blocks;

Funded by
the European Union

- To require holders of mining rights to work their claims rather than allowing them to preserve their title by paying annual fees;
- To require miners to participate in funds and to make other provision to meet the cost of restoring the environment when their mining operations come to an end;
- To convert certain special grants into mining leases;
- To remove much of the excessive particularity from the Act (for example, the detailed provisions setting out the way in which claims must be pegged) and leaving such matters to be prescribed in regulations;
- To make provision for the indigenization and localization of the mining industry at the primary level of mining;
- The introduction of the concept of the concept of "strategic minerals" to which special conditions by mutual agreement between the Minister and the State will attach;
- Generally, to make the procedures under the Act more transparent and to allow aggrieved persons a right of appeal to the Administrative Court against decisions which affect their rights.

The amendment of the Mines and Minerals Act is expected to provide clarity and certainty of the rules governing investment in the Mining sector. Furthermore, the fiscal framework that governs the mining sector is provided for in the Income Tax Act [Cap. 23:06]. Income Tax in Zimbabwe is source based and the rates of tax and deductions are fixed through by the Finance Act [23:04], which is generally revised on annual basis. The general corporate income tax rate across all sectors is 24%.

Government uses the tax system to achieve two competing objectives of generating revenue from taxing the mining enterprises and using tax expenditures tax expenditures (which are benefits granted to specific sectors, activities, or groups of taxpayers through preferential tax treatment, including exemptions, deductions, credits, deferrals, and reduced tax rates) to incentivize investment in the mining sector. Mining sector incentives outlined in the Income Tax Acts and updated various Finance Acts as shown in table 15 include the following:

Allowable deductions/expenditure (all capital expenditure) on exploration, development and operations incurred wholly and exclusively for any mining operations is allowed in full against taxable income. Expenditure incurred during a year of assessment on surveys, boreholes, trenches, pits and other prospecting and exploratory works undertaken for the purpose of acquiring rights to mine minerals in Zimbabwe or incurred on a mining location in Zimbabwe, together with any other expenditure that is incidental thereto, may be allowed in full, unless the taxpayer elects to carry the expenditure forward and be allowed against income from mining operations in subsequent years.

Assessed Losses / Indefinite Carry-over of losses: There is no restriction on carryover of tax losses. Thus, loses can be carried forward for an indefinite period.

Taxable Income of a Holder of Special Mining Lease- in the case of a holder of a Special Mining Lease (SML), corporate income is taxed at a special rate of 15%.

However, holders of a SML are liable to Additional Profits Tax (APT). APT is payable upon attaining a formula-based level of profitability as provided in the Income Tax Act [Cap. 23:06].

Funded by
the European Union

Section 36 (1) provides exemption wholly or partly from any tax charged under section twenty-six, thirty, thirty-one or thirty-two to holders of special mining leases if it is deemed to be in the interests to Zimbabwe[11]. These tax categories include non-resident shareholder tax; tax on fees, remittances, and royalties respectively.

Tax Incentive	Législative Provision
Exemption from Corporate Income Tax for the first 5 years of operation. Thereafter, a corporate tax rate of 15% applies.	Section 3(b) of Finance Act No. 2, of 2017
Special Initial allowance on capital equipment to be allowed at the rate of 50% of cost from year one and 25% in the subsequent two years.	Section 3 of Finance Act No. 2, of 2017
Specialised expatriate staff will be taxed at a flat rate of 15%.	Section 3(a) of Finance Act No. 2, of 2017
Exemption from Non-residents tax on Fees on services that are not locally available	Section 17 of Finance Act No. 2, of 2017
Exemption from Non-residents tax on Royalties	Section 18 of Finance Act No. 2, of 2017
Exemption from Non-residents tax on Dividends	Section 15 of Finance Act No. 2, of 2017;
Exemption from Residents tax on Dividends	Section 16 of Finance Act No. 2, of 2017
Duty free importation of Capital equipment for Special Economic Zones	Statutory Instrument 59 of 2017
Duty free importation of raw materials and intermediate products imported for use by companies set up in the Special Economic Zones	Statutory Instrument 59 of 2017

Table 14 Tax Incentives and Legislative Provisions

The multiple tax rebates, concessions and exemptions provided for in the Income Tax Act also result in foregone revenue by the State. In the 2022 National Budget Statement the government pronounced its intention to evaluate the impact of tax expenditures on socio-economic outcomes. A study evaluating tax expenditures commissioned by the Government of Zimbabwe is currently underway. Financial engineering by mining companies which enables them technically to continue declaring losses has also been noted as a threat undermining revenue collection from the mining sector. In this regard the provision of indefinite carry over of losses provided for in the mining sector incentives framework has been abused and not achieved the intended policy objective.

Key Institutions Involved in the Collection and Management of Mining Revenue

Zimbabwe Revenue Authority (ZIMRA) is the key institution mandated to collect government revenue through the different tax heads (i.e., corporate income tax, pay as you earn, custom duties and levies). There are also multiple fees and license fees that constitute revenue from the mining sector which are collected by institutions like the Environmental Management Agency (EMA); Ministry of Mines and Mining

[11] source (zimlii.org)

Funded by
the European Union

Development and Rural District Councils (RDCs). The following Government Ministries, Departments and Agencies play a key role in regulating and collecting revenue from the mining sector:

1. Ministry of Mines and Mining Development: the parent ministry of the mining sector. Its responsibilities include regulating the sector, administering the mining laws, reviewing mining license applications, and issuing respectively. This is mainly done through the Mining Affairs Board.
2. Ministry of Finance and Economic Development: responsible for leading and guiding the formulation of the mining fiscal regime and managing all mining revenue deposited in the Consolidated Revenue Fund.
3. The Zimbabwe Revenue Authority (ZIMRA: responsible for administering and enforcing all taxes applicable to the mining sector. It also advises the Government on mining fiscal and economic matters such as mining revenue forecasting.
4. Minerals Marketing Corporation of Zimbabwe (MMCZ): responsible for marketing and selling all minerals produced in Zimbabwe, except for gold and silver. Thus, it is required by ZIMRA to deduct royalties on precious stones, precious metals (other than gold), base metals, industrial metals, coal bed, methane, and coal at source. Royalties are charged based on the face value of the invoice and should be remitted to ZIMRA on or before the 10th day of the following month in which such deductions are made.
5. Reserve Bank of Zimbabwe: the Bank or its subsidiaries such as Fidelity Printers and Refiners Pvt. Ltd are also required by ZIMRA to deduct royalties on gold at source.
6. Chamber of Mines: required by ZIMRA to deduct royalties on gold at source and remit to ZIMRA on or before the 10th day of the following month in which such deductions are made.

Zimbabwe does not have institutions that are available in other mining jurisdictions to monitor the contribution of the players in the mining sector to government revenue. For example, Zimbabwe does not have fully fledged Minerals Audit Agency (MAA) responsible for auditing the quality and quantity of minerals produced and exported by miners. This limited capacity to physically audit mineral production and exports implies that revenue accruing to government from mining activities could be understated. Government approved a country wide Mining Audit to be conducted for two months May to June 2023[12]. The objective of the initiative was to ensure that all mining operations are conducted in accordance with the country's laws. The audit team comprised of multiple government Ministries, Department and Agencies[13].

Furthermore, Zimbabwe's legal provisions governing mining information disclosure is scattered in various pieces of legislations. Disclosure stipulated in the mines and minerals Act for example largely relates to

[12] 10th Post-Cabinet Press Briefing.pdf (veritaszim.net) - see section 5.1.

[13] Ministries of Mines and Mining Development, Lands, Agriculture, Fisheries, Water and Rural Development, Local Government and Public Works, Energy and Power Development and Environment, Climate Change, Tourism and Hospitality Industry; Department of Immigration and Labour; Zimbabwe Revenue Authority; Environmental Management Agency and Zimbabwe Republic Police.

Funded by
the European Union

the commercial interest of the companies and tends to be blind on policies and performance relating to business ethics, the environment and, where material to the company, social issues, competitiveness of the mining sector, human rights, and other public policy commitments in line with international best practiced. More so, there are no legal provisions for performance monitoring of mining contracts in line with section 315 of the national constitution. The current transfer pricing regulations do not provide sufficient guidance on reporting procedures for taxpayers engaged in transactions with related parties. This tends to erode the revenue base and promotes profit shifting arrangements arising from business transactions between related parties. Further, there are no clear punitive measures to deter corruption tendencies.

There is further lack of enforcement of the current legal statutes related to mining activities or disclosure of information listed companies disclose by way of financial reporting and disclosure differs with where the companies are registered. Mining companies in Zimbabwe are mandated to disclose information under the statutory provisions that also tie non mining companies like the Company Act, the Zimbabwe Stock Exchange Act and the income Tax Act except for the Mines and Minerals Act. This is unlike jurisdictions which have adopted specific legal framework on mining information disclosure. Mining companies with operations in Zimbabwe but are directly or indirectly listed on foreign bourses are governed by more transparent and strict mining codes and statutory requirements in the jurisdiction in which they are registered. Mining and mineral revenue information is fragmented and this to some extent explains why there has been debate, mistrust and confusion among stakeholders.

The government discloses mining information to some extent but does not go beyond the statutory requirements. Information provided by the government agencies is often highly aggregated, inaccessible, and untimely produced contrary to statutory requirements and often does not meet the needs of the users. There is to some extent non coordination on information sharing amongst government departments/ institutions relevant for disclosure of mining information are not well coordinated, rather they work in silos. They further face institutional, human resources regulatory capacity challenges to ensure effective implementation of the disclosure framework in its current state.

Some of these challenges include inadequate skills to synthesize mining and appropriately package mining information; lack capacity to enforce compliance or compel mining companies to disclose information on mining activities; lack of adequate skills to conduct mining audit; limited knowledge of the geology and mineralization of the country; lack of specialized metallurgical laboratories to verify and conduct specialized assaying process; inadequate weigh bridges.

Zimbabwe's disclosure framework requires strengthening through legal reforms that promote performance monitoring of mining contracts; sufficient guidance on reporting procedures for taxpayers engaged in transactions with related parties; clearly lay down punitive measures to deter corruption tendencies and increased value chain actor coordination. Human capacity building is imperative across the mining value chain in order to enhance information disclosure. Government needs ongoing skills strengthening and development in ongoing auditing, monitoring, regulating and improving resource exploitation regimes, contract negotiation, and compliance enforcement. There in need for improvement in data collection and reporting along the mining value chain. This data has to be more disaggregated and

Funded by
the European Union

further improvements in quality and content are much sought. There is need for increased coordination and proactive sharing of information by government entities; private and public companies; civil society and mining communities.

3.2. Macroeconomic context for in-country financings

According to the fourth World Bank Zimbabwe Economic Update (ZEU) the country's economic growth is projected to slow to 3.5 percent in 2024, a decrease from 4.5 percent in 2023, as agricultural output is expected to suffer from depressed global growth and the predicted erratic and below-average rainfall caused by the El Niño weather pattern. The report also notes that Zimbabwe's economy has seen a strong rebound since the COVID-19 pandemic, making it one of the fastest-growing economies in the Southern African Development Community (2021, 2022, and, so far, in 2023). In previous years, Zimbabwe faced increased global turmoil, while expansionary monetary policy has put initial pressure on inflation and the exchange rate. Yet, since June 2023, the Government proactively tightened monetary policy to bring down inflation and the parallel market premium. It also extended the use of US dollars as legal tender until 2030, further reducing policy uncertainty. Thus according ZEU report while Zimbabwe's economic outlook appears moderate, it reflects continued global headwinds, structural bottlenecks, weather-related shocks, and price and exchange rate volatility. Prolonged global turmoil could result in a slowdown in global output, reduced trade and investment, increased volatility in commodity prices, and supply disruptions. Moreover, fiscal pressures may result in an expansionary economic policy. This could increase economic volatility, impacting private sector activity and growth.

In 2018 Zimbabwe adopted a National Vision to achieve an empowered and prosperous upper middle-income society by 2030. Vision 2030 charts a new transformative and inclusive development agenda, which is expected to deliver broad based transformation, new wealth creation and expanding horizons of economic opportunities for all Zimbabweans. The achievement of Vision 2030 is envisaged to be anchored on the implementation of the following strategic programmes, supported by appropriate annual National Budgets:

- The Transitional Stabilization Programme (TSP). October 2018 to December 2020.
- Two Five-Year National Development Strategies, with the first one running from 2021-2025, and the second covering 2026-2030.

The TSP focused on fiscal consolidation, economic stabilization, and stimulation of growth and employment creation. Adoption and implementation of prudent fiscal and complementary monetary policies anchored investor confidence and stabilized the macroeconomic environment. TSP policies, strategies, and projects guided Zimbabwe's social and economic development interventions up to December 2020 and laid a base for economic growth for the period 2021-2030. Government's intention was to provide a supportive macro-economic and ease of doing business environment to stimulate financing of private sector investments especially in the mining sector that is attracting investor interests. During the TSP period the US$12 billion Mining Industry roadmap was launched; US$4.2 billion Great Dyke

Funded by
the European Union

Investments Platinum and US$4 billion Karo Resources Mhondoro-Ngezi platinum; Arcadia lithium mine commenced; coal production increased as new coal mines opened and preparatory work for on US$ 25 million Invictus Energy Oil and Gas Project in Muzarabani started. In this regard a key success of TSP is the operationalization of Zimbabwe Investment Development Agency (ZIDA)[14] as a one stop investment shop responsible for investment promotion.

Macroeconomic stability is seen as a critical ingredient and important precondition for mobilising investment finance that lubricates economic transformation and diversification. Historically the country's macroeconomic performance has been characterised by cycles of booms and slumps since 1980, reflecting both the impact of exogenous shocks such as droughts and floods; shortage of foreign currency; low investor confidence; volatility of international commodity prices; financial/economic crisis; pandemics (i.e. COVID 19); internal productivity challenges and policy/regulatory/legislative distortions. An analysis of the evolution of key macroeconomic indicators since 1980, shows a discernible pattern where the economy enjoyed greater success in three decades 1980-1990, 1991-2000 and 2010-2018. The average growth rates for the three decades were 4.3%, 0.7% and 7.44%, respectively. The economy experienced a major economic crisis from 2001 to 2007, losing close to half of its Gross Domestic Product (GDP) and undermined by hyperinflation. The economy had a strong rebound of GDP growth during the period 2010 to 2018 following the stabilisation effects of the multi-currency system (dollarisation) adopted in 2009. The growth was largely driven by commodity price booms and by good mining sector performance including the discovery and mining of alluvial diamonds in the Marange Diamond fields.

Real GDP growth rate increased from 4.7% (2017) to 5.5% (2018) in response to the TSP policy measures. The economy contracted by -6% and -4.1% respectively in 2019 and 2020. The contraction was induced by several factors including COVID-19 pandemic; devastating impacts of climatic shocks associated with drought and Cyclone Idai, which all had profound impact on the country's health system, livelihoods, and the economy at large. Economic growth recovered to 8.4% and 6.5% in 2021 and 2022 driven by strong recovery in agriculture, mining, electricity, construction, transport, and communication as well as finance and insurance. The economy is estimated to grow by 5.5% in 2023. Table 16 depicts the main sectoral contributions to GDP which were dominated by wholesale and retail trade, mining, agriculture, and manufacturing for the period 2022 to 2023. The mining sector which has the second largest weighing in the economic growth is projected to grow by 7.6% in 2024.

	Weight	2022	2023	2024	2025	2026
Agriculture, Hunting and Fishing and forestry	12.0	6.2	11.1	-4.9	10.1	5.2
Mining and quarrying	**13.2**	**10.5**	**4.8**	**7.6**	**4.9**	**4.8**
Manufacturing	11.2	1.6	2.2	1.6	2.7	2.5
Wholesale and retail trade; repair of motor vehicles	18.7	4.6	5.5	4.2	4.4	7.4
Information and communication	6.2	14.1	9.4	4.8	6.4	5.4

[14] ZIDA which repealed the Zimbabwe Investment Authority Act, the Special Economic Zones Act and the Joint Ventures Act, all which were dealing with investors separately was launched on 17 December 2020. ZIDA is now effective a one stop Investment Service Center for Investors.

Funded by
the European Union

Financial and insurance activities	8.2	15.6	6.1	4.5	3.9	4.4
Overall Growth Rate		**6.5**	**5.5**	**3.5**	**5.0**	**5.0**

Table 16 Main sectoral GDP Growth Rate (%) Source: MOFED, ZIMSTAT, RBZ

In terms of the composition of GDP in 2024, agriculture, mining and manufacturing contribute 11.6%, 13.7% and 10.6%, respectively. The manufacturing, mining, wholesale, and retail sectors accounted for 7.8%, 7.6% and 17.6% of employment in 2019[15]. The country's exports are also dominated by primary exports led by Gold and Platinum Group of Minerals (PGMs) and Lithium in mining sector as shown in table 17.

	2023		2024	*22/23 Change (%)*	*23/24 Change (%)*
Agricultural Exports	**1,240.1**		**1,316.3**	***16.2***	***6.1***
Mineral Exports	**5,628.8**		**5,891.5**	***1.0***	***4.7***
Gold	1,871.1		1,818.8	*-6.3*	*-2.8*
PGMs	1,403.6		1,328.4	*-36.8*	*-5.4*
Chrome & HCF	455.8		480.1	*3.1*	*5.3*
Diamonds	476.8		290.4	*222.5*	*-39.1*
Coke	185.7		209.6	*28.2*	*12.9*
Lithium	717.9		1,216.2	*917.0*	*69.4*
Nickel	58.6		61.3	*-8.2*	*4.6*

Table 17 Merchandise Exports (US$M) Source: MoFEDIP, 2023

Gross Domestic Product (GDP) analysis

According to the World Bank, Zimbabwe's GDP was worth 20.68 billion US dollars in 2022. Zimbabwe's GDP has fluctuated over the years, reflecting the political and economic challenges faced by the country. Zimbabwe's GDP growth rate in 2022 was 3.4 percent, which is higher than the previous year's rate of -7.82 percent. However, Zimbabwe's GDP per capita, which measures the average income of its population, was only 1,267 US dollars in 2022, which is one of the lowest in the world. Table 17 shows projected sectorial contribution to 2024 with agriculture, mining and manufacturing contributing 11.6%, 13.7% and 10.6%, respectively. The contribution of the mining sector is expected to be consistent over the period 2022 to 2024.

	2021	2022	2023	2024
Agriculture, Hunting and Fishing and forestry	12.0	12.0	12.6	11.6
Mining and quarrying	12.8	13.2	13.2	13.7
Manufacturing	11.7	11.2	10.8	10.6
Wholesale and retail trade;	19.1	18.7	18.8	18.9

[15] *ZIMSTAT, 2019a and Government of Zimbabwe, 2020b*

Funded by
the European Union

Table 18 Main Sectoral Contribution to GDP (%) Source: MoFEDIP (2023)

The contribution of different minerals to the mining sector output are shown in table 18 with gold playing a dominant role. Critical minerals such as lithium, copper, nickel, and platinum group of minerals (PGMs) will have a significant contribution to the mining sector output over the period 2022 to 2024. Thus, the performance of the mining sector in general and critical minerals in particular have immerse potential to drive economic

growth assuming stability in international prices.	Weights	2022	2023 Initial	2023 Rev	2024 Proj
Overall Growth		**12.4**	**9.1**	**4.8**	**7.6**
Cobalt \t	*0.2*	211.2	387.0	350	580
Copper \t	*1.4*	10,168.1	9,684.0	10,473	10,200
Lithium \t	*0.3*	102,420	881,709	881,709	Historically1,1 13,965
Iridium \t	*0.5*	601.2	672.0	619	637
Nickel \t	*5.4*	14,259.7	14,300.0	14,300	14,690
Palladium \kg	*16.1*	13,934.6	13,481.0	14,214	14,639
Platinum \kg	*11.3*	16,459.9	16,500.0	16,954	17,462
Rhodium \kg	*3.6*	1,461.1	1,551.0	1,505	1,550

Table 19 Mining Sector Output (thousand tonnes) Source: MoFEDIP, ZIMSTAT

Foreign Exchange (FX) and Inflation

Historically, Zimbabwe has grappled with insufficient foreign exchange reserves; allocation of the scarce foreign currency; exchange rate management; management of money supply growth; high inflation induced by monetization of fiscal deficits and inflation expectations. Thus, short-term stabilization policies have dominated the macroeconomic policies design stabilize the economy and lay the foundation for long term economic growth and development. In 2019 government reintroduced the local currency which had been abandoned in 2009 when the economy dollarized, through Statutory Instrument 142 of 2019[16] along with other monetary reforms to stabilize the exchange rate. The Government further introduced a new Foreign Exchange Trading System (the Dutch auction rate system)[17] on 23 June 2020 to foster transparency and efficiency in the trading of foreign exchange. The introduction the foreign exchange trading system managed to temporarily stabilize the official exchange rate at US$1 to throughout the months of July to November, while the parallel market exchange rate premium, which had risen to more than 300% when the auction was introduced has fallen to less than 10%, a tolerable parallel market premium based on international best practice (GoZ, 2021). This in turn, anchored inflation expectations and slowed down the increase in prices witnessed before June 2020.

However, the instability of the exchange rate characterized by the divergence between the official exchange rate and parallel market rate have kept recurring. Inflation has continued to raise even when the other macroeconomic fundamentals were stable due to the pass through from the exchange rates which have anchored the high inflation expectations. Thus, the Zim dollar kept depreciating as depicted by the exchange rate that changed during the weekly auctions18 and in the process inducing skyrocketing

[16] S. I. 142 of 2019 Reserve Bank of Zim (Legal Tender) Regulations, 2019 -1.pdf (veritaszim.net)

[17] Foreign Exchange Auction Trading System (rbz.co.zw) and EXCHANGE-CONTROL-RV175.pdf (rbz.co.zw).

[18] See Exchange Rates (rbz.co.zw) and Official And Unofficial Market Exchange Rates - Zimpricecheck

Funded by
the European Union

prices. In this regard, the stabilisation of the exchange rate and reducing its pass-through to inflation has been the major pre-occupation of fiscal and monetary authorities over the period 2020 to 2023. Authorities have focused on tightening fiscal and monetary policies and moral suasion directives to influence the market particularly retailers who were accused of profiteering. The 2024 budget statement acknowledged that domestic prices have relatively been stable since the third quarter of 2023, as reflected by month-on-month inflation which declined from 12.1% in June 2023, to 4.5% in November 2023. The annual headline inflation declined from 30.9% in June 2023 to 21.6% in November 2023. In the outlook, annual inflation is expected to remain on the decline and is projected to end the year 2023 slightly below 20%. Annual inflation to end the year 2024 is projected to be slightly above 10%, premised on the effectiveness of the tight monetary and fiscal policies being pursued by Government (GoZ National Budget Statement, 2023). High inflation undermines savings mobilization and restrict the availability of investible funds as real interest rates become negative, thus undermining domestic investments which are supposed to act as a magnet to attract foreign direct investments.

Sovereign debt

Zimbabwe has been in debt distress since the year 2000, when the country first defaulted on its external obligations to the International Financial Institutions (IFS). The defaults resulted in the country being denied access to external financing by IFIs and other traditional multilateral and bilateral creditors. Consequently, Zimbabwe has not been able to access funding from traditional bilateral and multilateral creditors. The constrained access to external finance partly contributed to a decline in economic activity witnessed between 2000 and 2008. The low growth trajectory during the crisis period affected the country's debt carrying capacity and its ability to service debt. Prior to the 2000 crisis, Zimbabwe had a clean record of servicing its debt. Thus, it can be said that Zimbabwe's debt problem was not a result of imprudent borrowing, but merely reflects growth crisis, which compromised the sources of debt servicing, as measured by exports and or government revenues (Chigumira. et.al. 2018)[19].

The accumulation of external payment arrears resulted in the International Monetary Fund (IMF) declaring the country ineligible for the general resources account of the IMF financing window (IMF, 2001). Equally the same, other multilateral institutions, notably the World Bank and the African Development Bank (AfDB) and traditional creditors from the Paris Club also suspended disbursements of existing loan facilities and declared the country ineligible for new loans. The country has not been able to receive Official Development Assistance (ODA) from traditional creditors as well as balance of payments (BOP) support from the IMF. The country had been relying on semi concessional financing mainly from China as depicted by the exchange rate that changed during the weekly auctions. The lack of access to long-term capital has led to significant infrastructural deficiencies in the economy, thereby militating against the country's growth efforts. In particular, the road, rail, air, water, and energy systems have deteriorated significantly owing to under-investment in the sectors. This has forced several projects to be suspended or cancelled. Additionally, underlying fiscal constraints have undermined government's ability to inject meaningful investment in infrastructure and public service delivery (Chigumira at.al. 2018)

The Government of Zimbabwe Public Debt Report (2023) records that the total Public and Publicly Guaranteed (PPG) debt stood at US$17.7 billion, as at end September 2023, of which external debt amounted to US$12.7 billion (72 per cent) and domestic debt of US$5.0 billion (28 per cent). Of the total external debt stock, the bilateral and multilateral debt amounted to US$9.1 billion, of which 76% are principal arrears, interest arrears and penalties. The overall total stock of PPG external debt decreased

[19] An assessment of arrears clearance web (1).pdf (zepari.co.zw)

Funded by
the European Union

from US$12.8 billion in December 2022, to US$12.7 billion in September 2023. This was mainly due to the decrease in liabilities on the RBZ balance sheet by US$684.8 million (GoZ 2023).

The accumulation of external debt payment arrears since 2000, has resulted in the attraction of penalties on Zimbabwe's PPG external debt. The average interest rate for the PPG external debt portfolio is 6.3 per cent, with multilaterals averaging 4.16 per cent, while bilateral creditors average 4.4 per cent. The average penalty interest rate for multilateral creditors is 6.6 per cent, while for bilateral creditors it is at 6.2 per cent. The highest penalty rate for bilateral creditors is 12.2 per cent, from the French COFACE, while the highest penalty rate for multilateral creditors is 10.5 per cent from the European Investment Bank (EIB). The penalties have exacerbated Zimbabwe's external debt overhang position due to the prohibitive penalty rates, hence the need to urgently resolve the country's external debt distress situation (GoZ, 2023)[20].

The Government, in December 2022, established a Structured Dialogue Platform (SDP) with all its creditors and Development Partners, to institutionalize structured dialogue on economic and governance reforms to underpin Zimbabwe's Arrears Clearance and Debt Resolution process. The success of the Arrears Clearance and Debt Resolution process is critical for the country to unlock new external financing. The country's sustainable economic recovery agenda requires the support of Development Partners and International Financial Institutions, through a comprehensive Arrears Clearance and Debt Resolution process.

Foreign Direct Investment

Foreign direct investment and diaspora investments are considered as possible financing options underpinning the National Development Strategy (NDS1) together with fiscal revenues, loans, grants, public entities own resources, private sector resources and public private partnerships (PPPs). Foreign direct investment inflows into the country have generally been steadily increasing following a deep in 2020 first quarter, reaching a peak of US$95.8 million in the fourth quarter of 2022.

[20] Public Debt Report -Zimtreasury- ZPDMO – Parliament of Zimbabwe (parlzim.gov.zw)

Funded by
the European Union

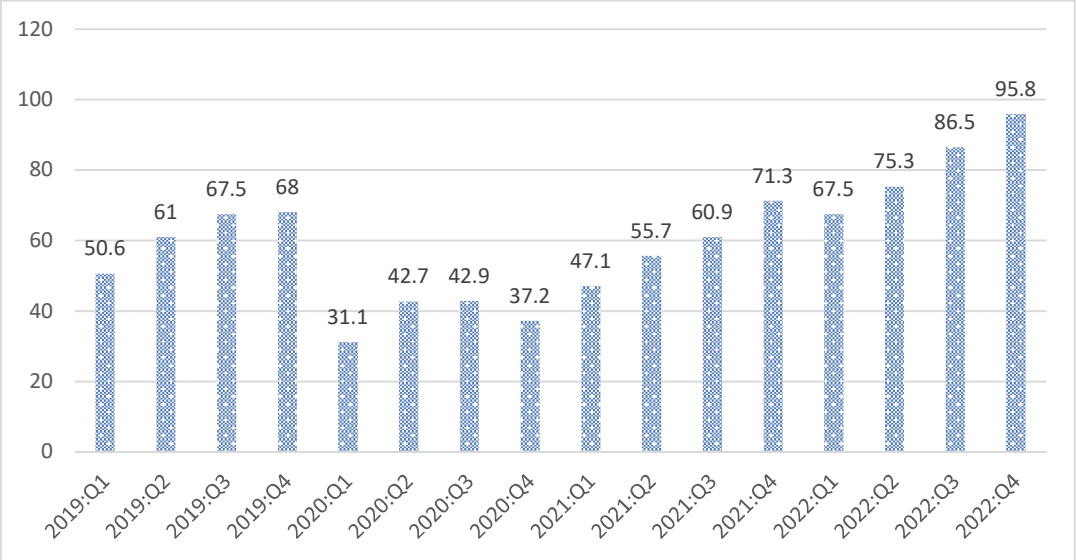


Figure 13 Foreign Direct Investment inflows (US$M)[21]

Similarly, during the period January to September 2023, Zimbabwe Investment Development Agency (ZIDA)[22] managed to draw investors from 38 countries and licensed investors increased to 469 from 178 recorded during the same period in 2022. To expedite the pace of economic transformation, Government seeks to upscale the doing business reforms that address the various legislative and administrative bottlenecks. This will be complemented by other reform measures under the Structured Dialogue Platform, for debt and arrears clearance as well as tax revenue and administration reforms already underway.

Trade agreements

Zimbabwe is a founder Member State of the Southern African Development Community (SADC), having been one of the nine countries that formed the Southern African Development Coordination Conference (SADCC) in Lusaka, Zambia, in April 1980. SADCC transformed into SADC in 1992 with the signing of the SADC Treaty in Windhoek, Namibia[23]. Zimbabwe also belongs to the 21-nation Common Market for Eastern and Southern Africa (COMESA) that seeks to promote regional integration through trade and the development of natural and human resources for the mutual benefit of all people in the region. COMESA provides for reduced duties on imports from member countries subject to certain rules of origin. Zimbabwe has bilateral trade agreements with Namibia, Botswana, and South Africa. Zimbabwe also signed the interim Economic Partnership Agreement (EPA) under the Eastern and Southern African (ESA) bloc with the European Commission in 2009. The EPA offers duty-free and quota-free market access to all exports from ESA countries who are signatories to the EPA. In addition, Zimbabwe officially joined the African Continental Free Trade Area (AfCFTA) in February 2020 which aims to create a single continental market for goods and services, eventually leading to the establishment of a Customs Union[24]. All these trade agreements open a huge market for Zimbabwe's manufactured exports. Thus, investing in

[21] Source: RBZ (2023) and National Budget Statement (2023)
[22] Home - ZIDA (zidainvest.com)
[23] Zimbabwe | SADC
[24] Zimbabwe - Trade Agreements

Funded by
the European Union

increased capacity for value added minerals and mineral based manufacture exports have ready markets in regional and continental trading blocs.

Restrictions on imports/exports

Import substitution has been identified in NDS1 as one of the key strategies for foster sustainable balance of payments and domesticating key value chains that will ultimately propel export led growth in the medium to long term. This also entails reviewing of tariff and non-tariff measures to enable importation of critical raw materials and capital goods. To consolidate external sector stability, a combination of export orientation and import substitution strategies are being prioritized by government particularly where the country has competitive advantage. Export orientation, strategies are focused on promoting export products and export markets diversification. These strategies are being complemented by enhancing export promotion activities, market access negotiations, and institutional capacity building of trade promotion organizations[25].
Acceleration of value addition and beneficiation of agriculture and mining production is one of the macroeconomic objectives of NDS1. The focus on value addition and beneficiation is viewed as a strategy to transform the economy from a producer and exporter of primary commodities to a producer and exporter of differentiated value-added products. Currently Zimbabwe's export basket has a high concentration of primary commodity exports dominated by minerals and raw tobacco. In this regard Government, is promoting investment in value addition to transform Zimbabwe's economic structure from one highly dependent on the export of minerals and agricultural raw materials to an economy trading high value processed goods. Thus, the focus of value addition and beneficiation has led government to ban the export of some designated unprocessed products.

Pleas had been made over the years for mining companies to engage in value addition to the minerals before they are exported to increase the revenue generated from mineral exports. This culminated in a series of statutory instruments by the Minister of Mines and Mineral Development in which the export of raw base minerals was prohibited and only allowed in certain circumstances. Under the Base Minerals Export Control Act [Chapter 21:01], the Minister is empowered to put in place rules regulating the export of base minerals. In July 2022, the Minister issued an order banning the exports of unprocessed granite through the Mines and Minerals (Prohibition Order of Exportations of Unprocessed Granite Notice, 2022). A further statutory instrument was put in place banning the export of un-beneficiated lithium through Statutory Instrument 213/2022. This was repealed a few weeks later and replaced by the Base Minerals Export Control (unbeneficiated Base Mineral Ores) Order, 2023, which was gazetted on 6 January 2023 as Statutory Instrument 5/2023. In terms of this Order, a written permit issued by the Minister of Mines and Mining Development is required before one can export un-beneficiated base mineral ores. This was primarily directed at the lithium sector, given the rush towards the mining of this mineral that hit the country in 2022[26].

To mitigate the adverse effects of the volatility of international commodity (i.e. metal) prices the Government in the 2024 budget is prioritizing measures to intensify value addition and beneficiation, particularly of minerals and agricultural products, in order to increase the value of export receipts, as well as insulate the economy against the volatility of international commodity prices.

[25] These include the ZimTrade, Zimbabwe Tourism Authority, the Competition and Tariffs Commission, Standardization bodies and the Zimbabwe International Trade Fair Company.

[26] Mining Laws and Regulations Report 2024 Zimbabwe (iclg.com)

Funded by
the European Union

The extraction, beneficiation, and value addition of critical minerals like lithium are expected to drive the growth of the mineral and quarrying sub-sector to meet the GDP growth targets as envisaged in NDS 1 and 2024 Budget Statement. For example, Prospect Lithium Zimbabwe commissioned a $300 million lithium processing plant in Zimbabwe on 5 July 2023. The plant which will process 4.5 million metric tons per year of hard rock lithium into concentrate for export, began initial processing in April 2023 and has since then, and exported close to 30,000 tons. This equates to US$40 million in revenue generation in Zimbabwe[27]. Lithium as expressed by the country's President at the commissioning of the plant is viewed as the mineral of the present and the future as its beneficiation and value addition is expected to position the country as an emerging and competitive player in the global lithium value chain. Global demand for lithium has surged in recent years because of its use in electric car batteries. As a result, Zimbabwe has drawn investors in battery minerals from Canada, the United Kingdom, and Australia, although China remains the dominant player[28].

3.3. Political context for in-country financings

Vines (2023) observed that geopolitical competition in Africa has intensified in 2022, particularly among great powers such as China, Russia, the US, and the EU but also by middle powers such as Turkey, Japan, and the Gulf states. He further noted that international competition to secure Africa's critical and strategic minerals and energy products intensified in 2022 and that decarbonization is becoming a driver of resource nationalism and geopolitical competition in certain African mining markets, home to large deposits of critical 'transition minerals' such as copper, cobalt, graphite, lithium, or nickel[29].

Rouget (2023) also observed that, as a supplier of many of the world's critical minerals for the energy transition, the continent and its mining sector are also increasingly at the heart of geopolitical competition. This is already triggering a wave of interest from major geopolitical players, most visible in the US's re-engagement with African producers such as Zambia and Congo (DRC). Graphite, lithium or rare earths deposits, for example, were cited as seeing increased exploration activity and competition from Chinese and Western off takers. Rouget (2023) further observed that economic pressures will shape the risk environment for Africa's mining investors in many ways. As a critical source of tax revenue, foreign exchange and formal employment, miners will find it hard to escape the spotlight. Government will expect large taxpayers to increase their contribution to fiscal revenue and job creation. Binding fiscal constraints will reduce state support for large mining operations.

EIU (2023) also noted that African mining ventures, especially those in Botswana, the Democratic Republic of Congo (DRC), Namibia, Nigeria, Sierra Leone, South Africa, Tanzania, Zambia and Zimbabwe, could receive more attention should Western based mining companies and commodity traders increasingly shun Russian supplies of copper, cobalt, diamonds, gold, iron ore, manganese, nickel, platinum, palladium, tungsten, uranium, vanadium and zinc, among other products[30].

[27] Zimbabwe Commissions $300M Lithium Processing Plant (energycapitalpower.com)
[28] See Chinese mining company opens lithium processing plant in Zimbabwe | Africanews
[29] Africa in 2023: Continuing political and economic volatility | Chatham House – International Affairs Think Tank
[30] Things to watch in Africa in 2023 (eiu.com)

Funded by
the European Union

The emerging political risks highlighted above will combine with the country specific risks to determine the risk profile that the investors in critical minerals must grapple with. The country has enjoyed relative peace and stability that have attracted mining investor with a long-term view. The period leading to, and post national elections have in the past have political uncertainties. Instances of disputed polls and politically motivated violence have also increased country political ratings in the past which adversely affected investor perception.

Since 2017 the government has adopted an engagement and re-engagement policy with the mantra that Zimbabwe is open for business.

The Indigenization and Economic Empowerment Act [Chapter 14:33] of 2007, section 3 (1) which stated that, *"The Government shall, through this Act or regulations or other measures under this Act or any other law, endeavor to secure that— (a) at least fifty-one per centum of the shares of every public company and any other business shall be owned by indigenous Zimbabweans*" has generated negative publicity and risk of appropriation which have been a deterrent to investors in all sectors of the economy.

Government through budget statements have tried to clarify policy and dispel negativity associated with the policy. This resulted in amendments to the Act in 2011; 2016; 2018 (through section 42 of the Finance (No. 1) Act, p.20)[31] and section 36 of Finance (No.2.) Act, 2020[32], p.136. In 2021 Indigenization and Economic Empowerment Act [Chapter 14:33][33], was updated capture all these amendments. Section 3 (1) of the updated Act state that, "*The State shall, by this Act, or through regulations under this Act or any other law, secure that at least fifty-one per centum of the shares or other ownership interest of every designated extractive business, that is to say a company, entity or business involved in the extraction of such mineral as may be prescribed by the Minister in consultation with the Minister responsible for Mines and the Minister responsible for Finance shall be owned through an appropriate designated entity (with or without the participation of a community share ownership scheme or employee share ownership scheme or trust, or both)*".
Government also implemented the ease of doing business reforms which culminated in the establishment of ZIDA as a one stop investment centre as part of measures to boost investor confidence.

[31] finance act 2018.pdf (veritaszim.net)

[32] 64549-L Finance Act (No. 2.) 2020 Gold.indd (veritaszim.net)

[33] Indigenisation & Economic Empowerment Act Updated Jan 2021.pdf (veritaszim.net)

Funded by
the European Union

4. Assessment of social, environmental, and governance challenges

4.1 Country-level assessment and context

4.1.1. Context

The country's Vision 2030 seeks to ensure sustainable mining by stakeholders through a well governed mining sector which is ethically inclusive, environmentally friendly, and socially responsible and appreciated by surrounding communities. In the wake of the United Nations Conference on Climate Change (COP, 26)[34] held in Glasgow, countries committed to ambitious net zero and decarbonization targets. This placed a focus on Environmental Social and Governance reporting by mining sector enterprises given their high carbon footprint and environmental impact. The need to comply with ESG reporting is placing pressure on companies to significantly change their business model and recalibrate the risks attached to their operations. Compliance of ESG reporting is being seen as a good corporate citizenship; a requirement to access funding from ESG focused institutional investors and a protection of investments by avoiding material financial risks arising from climate change, worker disputes, human rights issues in supply chains and poor corporate governance.

A myriad of reporting frameworks that are used by companies internationally to prepare ESG reports, include the Global Reporting Initiative (GRI), Sustainability Accounting Standards Board (SASB) and the Taskforce on Climate-related Financial Disclosures (TCFD) recommendations among others. All these frameworks give companies a leeway to adapt the standards that suit their industry. However, the World Economic Forum (WEF) has developed a consultation Discussion Paper entitled Towards Common Metrics and Consistent Reporting of Sustainable Value Creation[35].The Discussion Paper seeks to provide a general framework for companies to demonstrate their long-term sustainability; a framework that integrates financial metrics along with relevant non-financial criteria such as ESG considerations, gender equality, compensation practices, supply chain management, and other activities.

The European Union (EU) has also issued a set of 13 exposure drafts of European Sustainability Reporting Standards (ESRSs) for companies located in EU member states. These standards introduce extensive new disclosure requirements that apply to most listed and large companies located in the EU, including large European subsidiaries of foreign parent companies[36]. In April 2021, the European Commission adopted a legislative proposal for a Corporate Sustainability Reporting Directive (CSRD) that requires companies within its scope to report using a double materiality perspective in compliance with European Sustainability Reporting Standards (ESRS) adopted by the European Commission as delegated acts[37]. KPMG (2022) observed that success in the long run will become increasingly dependent on defining

[34] COP stands for Conference of the Parties, the countries that signed the United Nations Framework Convention on Climate Change (UNFCCC) which was adopted in 1992.

[35] WEF_IBC_ESG_Metrics_Discussion_Paper.pdf (weforum.org)

[36] EU publishes exposure drafts of sustainability standard - KPMG Denmark;

[37] First Set of draft ESRS - EFRAG

Funded by
the European Union

success in more than just financial terms, requiring the need to look more holistically at stakeholder returns, including governments, communities, and employees.

In Zimbabwe, Statutory Instrument 134 of 2019 sections 400 under Sustainability reporting, requires companies that are listed on Zimbabwe Stock Exchange (ZSE) to produce an ESG report which shows how mining companies are addressing social, economic, and environmental related concerns in the areas which they are operating. The Statutory Instrument (SI) further states that the issuer must disclose its sustainability policy, including mitigation of risks, sustainability performance data and other material information which deepens stakeholders' understanding of corporate performance. The issuer is expected to provide a balanced and objective view of their performance by including both positive and negative impacts on environment and society, how it relates to its stakeholders and contributes to sustainable development.

Section 401 of the SI highlights that the ZSE encourages the adoption of internationally accepted reporting frameworks, such as the Global Reporting Initiatives (GRI) Sustainability Reporting Guidelines or Standards, in disclosing the company's sustainability performance. Section 402 state that some issuers operate in industries that are extremely sensitive to environmental and social issues such as oil and gas, mining and metals sector with high environmental and social exposure and impacts that warrant specialized reporting frameworks for meaningful assessments of organizational risk and performance. Such companies are required by the ZSE to adopt industry-specific reporting framework or (b) the GRI Sector Supplements for selected industries; or (c) such internationally and nationally recognized reporting frameworks.

Overall, the issue of ESG reporting is still new phenomena in the mining sector in Zimbabwe. For example, Caledonia Gold mine published its first ESG report in 2021[38] which covers the period 1 January 2020 to 31 December 2020. The company noted in the preamble of the report that, this inaugural report was an important step towards improving communications on the Company's approach to ESG topics, as well as providing an update on the company's performance in this vital area of the business. While the Company was not reporting to any industry framework this ESG was its attempt to implement the principles of responsible mining. The report mapped each significant topic to relevant global and industry frameworks and standards to ensure applicability and a comprehensive reporting foundation. The company also recognized that this was an ongoing process which was evidenced by the publishing of the 2021 ESG report[39].

Zimplats, a leading platinum mining company, in its Integrated Annual Report integrates material aspects of the Group's environmental, social and governance impacts with the operational and financial performance of the business[40]. Furthermore, its operations are also covered in the parent company Implats South Africa's integrated ESG report[41] Bindura Nickel Corporation Limited, a fully integrated Nickel

[38] CMCL-ESG-REPORT-FINAL.pdf (wp-caledoniamining-2020.s3.eu-west-2.amazonaws.com)
[39] ESG-Report-2021-FINAL.pdf (wp-caledoniamining-2020.s3.eu-west-2.amazonaws.com)
[40] 2022-INTEGRATED-ANNUAL-REPORT.pdf (zimplats.com)
[41] ESG-spreads.pdf (implats-ir.co.za)

Funded by
the European Union

producer which is engaged in the mining and extraction of Nickel and the production of Nickel by-products (Copper and Cobalt) also reports on ESG issues within its annual report[42]. The Company's annual report for 2022 includes an extensive section on Sustainability Reporting which focuses on the identification, quantification and reporting on the impacts that BNC's sustainability efforts have achieved from its operations in the past and will achieve in the future.

Despite the few cases on ESG/Sustainability reporting cited above, adoption and implementation of ESG reporting in the mining sector is still in its infancy the full realization of its benefits is affected by the lack of a common framework of reporting among other challenges. It is expected that the results of the country wide Government Audit on Responsible mining that was conducted May and June 2023, will bring to the fore the weaknesses within the mining operations with regards to ESG issues as well as pro-offer remedial measures. The Multi-Ministry, Departments and Agencies involved in the Responsible Mining Audit was coordinated by the Ministry of Mines and Mining Development.

World Energy Investment (WEI, 2022)[43] observed that, prices for important energy transition minerals and metals have been on a sustained upward march since the start of 2021. WEI (2022) further highlighted that the prices for lithium and cobalt more than doubled in 2021 and those for copper, nickel and aluminum all rose by around 25-40%. The surge in cathode material costs increases the cost of Electric Vehicle (EV) battery packs. Cathode material include lithium, nickel, cobalt, and manganese.

Michael *et al* 2022, also observed that the recent price spikes for critical minerals have triggered a marked increase in investment in mineral exploration and production. The increase in mineral exploration and production exposes significant risks associated with the environmental, social and governance (ESG) impacts of mining projects. Michael *et al* 2022, further highlighted that these include risks associated with geopolitical tensions, armed conflict, human rights violations, bribery and corruption, emissions, water stress and loss of biodiversity. These types of impacts can erode public support for mining projects, and will face increasing scrutiny from downstream industries, investors, and civil society, potentially leading to short-term production disruptions and stark local and international resistance to mining investments. This may in turn limit the supply of crucial minerals and metals, potentially derailing clean energy transitions. In this regard, the surging investor interest in exploring and mining critical minerals in Zimbabwe, with lithium being the front runner, need to be properly managed to avoid exposure of companies to ESG-related regulatory, ethical, and reputational criticisms.

Carbajal Glass (2022) using the micro-geopolitics of organized crime' (MGPOC) framework examined how and why organized crime groups (OCGs) around the globe develop illicit economies associated to natural resources. The foundational premise underlying the MGPOC is that OCGs vie for contested resources-rich territories, transport routes, and access to national and international markets to secure strategic hubs of illicit wealth, influence, and power, thus creating conditions for large-scale violence primordially at a local scale. Using Zimbabwe lithium as a case study Carbajal Glass (2022) highlighted potential risks in

[42] BNC-AR-2022.pdf (minedocs.com)
[43] World Energy Investment 2022 (windows.net)

Funded by
the European Union

Zimbabwe's lithium industry represents of wider danger of conflict onsets over natural resources. The paper concludes that the way lithium is sourced will determine whether this energy transition supports peaceful, sustainable societies in countries like Zimbabwe or, instead, will pose a serious threat to human vulnerability.

4.1.2. Mineral/mining policies, industry policies

The Zimbabwe mining sector faces many challenges related to ESG, These include weak governance, environmental degradation, social conflicts, fiscal leakages and low productivity. To address these issues and promote sustainable development of the mining sector, Zimbabwe need is working towards implementing a comprehensive and coherent mineral policy framework that aligns with the best practices and standards of the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). According to a 2015 assessment by the International Institute for Sustainable Development (IISD), Zimbabwe has made some progress in developing its legal and policy framework for mining, but there are still significant gaps and inconsistencies that need to be addressed. For example, Zimbabwe has not adopted a clear mineral policy document that outlines its vision, objectives and strategies for the mining sector. The Mines and Minerals Act of 1961 is still being updated to address the current realities and challenges of the sector. The Environmental Management Act of 2002 provides some provisions for environmental protection, but it is not well enforced and monitored. The fiscal regime for mining is complex and opaque, with multiple taxes, fees and royalties that create uncertainty and inefficiency. The socioeconomic benefits from mining are not equitably distributed among different stakeholders, especially the local communities affected by mining activities. The mine closure and post-mining transition are not adequately planned and funded, leading to environmental liabilities and social problems. The Artisanal and Small-scale Mining (ASM) sector is largely informal and unregulated, posing serious risks to the environment, health and safety of miners and communities.

These challenges notwithstanding, there is a growing number of local communities and villagers in lithium rich areas of Zimbabwe that are participating in lithium mining and trading activities, attracted by quick money and forced by limited (formal) job opportunities in the country. This is despite the illegality of artisanal mining in Zimbabwe." By November 2022, reports indicated that an estimated 5 000 artisanal miners, fortune seekers and foreigners were involved in mining and trading lithium at Sandawana Mine"[44].

4.1.3. Mining regulations

The allocation of mining licenses in Zimbabwe is governed by various laws and regulations, such as the Mines and Minerals Act [Chapter 21:05], the Environmental Management Act [Chapter 20:27], and the Mining (General) Regulations. These laws and regulations establish the rights and obligations of mining title holders, as well as the procedures and fees for acquiring and maintaining mining titles. The mining

[44] IPIS Briefing – Summer 2023, by Zimbabwe Environmental Law Association (ZELA) *'Chinese dominance in Zimbabwe's lithium mines: Potential risks, vulnerabilities and opportunities in the critical minerals sector'.* https://ipisresearch.be/weekly-briefing/chinese-dominance-in-zimbabwes-lithium-mines-potential-risks-vulnerabilities-and-opportunities-in-the-critical-minerals-sector/

Funded by
the European Union

industry is administered by different authorities and functionaries, such as the President, the Minister and the Ministry of Mines and Mining Development, the Mining Affairs Board, and the Environmental Management Agency. The mining titles that can be obtained in Zimbabwe include prospecting licenses, mining leases, special mining leases, special grants, and sites. The type of title depends on the mineral, the location, and the size of the area to be mined. The allocation of mining licenses is subject to various conditions and restrictions, such as environmental impact assessment, indigenous ownership requirements, beneficiation and export controls, and land rights.

Since 2018 Zimbabwe re-focused its attention on maximizing the mining industry's potential, through re-structuring its policies and regulatory framework to improve investment and productivity. For example, the amendments to the Finance Act which came into effect on the 1st of January 2022 brought changes to the royalty rates in platinum and gold. Significant to the changes is the allowance for a 3% royalty rate on gold where global prices are below one thousand two hundred United States Dollars (US$1200) per ounce, this is a significant review from a flat 5% royalty rate that did not factor in the fluctuations in the price.

4.1.4. Taxation and royalties

Royalties are calculated on the gross fair market value or face value of the invoice issued either by the local designated entity (MMCZ, Fidelity Refiners and Printers) or as per an internationally recognized pricing standard such as applicable to platinum (London Metals Exchange). Below are the prevailing royalty rates as applicable from the 1st of January 2022.

Mineral	Method	Rate of Mining Royalty
Platinum	Concentrate- 85% of price on London Metal Exchange on the date of the transaction	2.5%
	Concentrate- 85% of price on London Metal Exchange on the date of the transaction	2.5%
Base metals	Invoice value by MMCZ	2 %
Coalbed Methane	Invoice value by MMCZ	2%
Coal	Invoice value by MMCZ	1%

Table 20 Royalty rates as applicable from the 1st of January 2022[45]

On the 4th of November the President published a Statutory Instrument, the Presidential Powers (Temporary Measures) (Amendment of Reserve Bank of Zimbabwe Act and Finance Act) Regulations, 2022 [SI 189 of 2022][46], which requires miners to pay royalties partly in kind, partly in foreign currency and

[45] Extracted from Finance Act No. 7 of 2021

[46] S.I. 189 of 2022 Presidential Regulations.indd (veritaszim.net)

Funded by
the European Union

partly in local currency. Royalties for platinum, lithium, and other minerals prescribed by the Reserve Bank in a statutory instrument must be paid:

- 50 per cent in kind, in a form and purity or quality prescribed by the Reserve Bank in a statutory instrument,
- 10 per cent in foreign currency (in cash), and
- 40 per cent in Zimbabwe currency.

Royalties for other minerals must be paid:

- 50 per cent in foreign currency (not necessarily in cash), and
- 50 per cent in Zimbabwe currency.

The Statutory Instrument also amends the Reserve Bank of Zimbabwe Act to permit the Bank to keep reserves of diamonds, platinum, and lithium. The Bank is given power to make statutory instruments specifying other minerals that may be kept as reserves.

4.1.4. Land-use and mineral rights

Land-use and mineral rights in Zimbabwe are governed by various laws and regulations, which aim to balance the interests of different stakeholders, such as the state, the land owners, the miners and the environment. Some of the key laws and regulations that affect land-use and mineral rights in Zimbabwe are:

- The Mines and Minerals Act [Chapter 21:05], which vests the right of searching and mining for and disposing of all minerals, mineral oils and natural gases in the President, subject to the provisions of the Act. The Act also regulates the acquisition, transfer, encumbrance and relinquishment of mining rights, as well as the environmental and social aspects of mining activities.
- The Environmental Management Act [Chapter 20:27], which provides for the protection and management of natural resources and the environment, as well as the prevention of pollution and environmental degradation. The Act also requires an environmental impact assessment to be conducted for any project that may have an adverse impact on the environment, including mining projects.
- The Land Acquisition Act [Chapter 20:10], which empowers the state to acquire any land for a public purpose, such as resettlement, urban development or mining. The Act also provides for the payment of compensation to the former owners of the acquired land.
- The Communal Land Act [Chapter 20:04], which regulates the use and occupation of communal land by rural communities. Communal land is vested in the President, who may allocate it to district councils or rural district councils for administration. The Act also prohibits any person from prospecting or mining on communal land without the consent of the rural district council concerned.

Land-use and mineral rights in Zimbabwe are therefore subject to various legal frameworks that may create conflicts or synergies among different actors. For instance, mining rights may take precedence over farming rights in some cases, depending on the type and location of the mineral resources, as well as the public interest involved. However, there are also opportunities for co-existence and collaboration

Funded by
the European Union

between miners and farmers, such as through land-sharing agreements, joint ventures or corporate social responsibility initiatives. Furthermore, land-use and mineral rights in Zimbabwe are also influenced by political, economic, and social factors that may affect the implementation and enforcement of the laws and regulations.

4.1.5. Environment

The **Environmental Management Act (EMA)** [Chapter 20:27] **of 1996**, is concerned with the overall management of the environment and with the implementation of policies and protocols to ensure the sustainability of resources. This Act t] provides for the establishment of the National Environmental Council, Environmental Management Agency, Environment Management Board, and the Standards and Enforcement Committee. It also stipulates general principles of environmental management, quality standards, environmental plans, environmental impact assessments and audits. Section 4 of this Act outlines environmental rights and principles of environmental management while Section 5 defines the general functions of the Minister of Environment and Tourism. Under this Act, the Minister may delegate to the Environmental Management Agency or National Environment Council such of his functions as he thinks fit.

Other key legislation governing the environmental regulation in Zimbabwe's mining sector include:

- Water Act [Chapter 20:24],
- Forest Act [Chapter 19:05],
- Agricultural Land Settlement Act [Chapter 20:01],
- Communal Land Act [Chapter 20:04],
- Parks and Wild Life Act [Chapter 20:14], and
- Rural Land Act [Chapter 20:18]

These legislations are intended to promote sustainable management of natural resources and protection of the environment, prevention of pollution, preparation of environmental plans and establishment of government agencies such as the Environmental Management Agency and the Environment Fund.

All exploration, reconnaissance, and mining operations must be approved by the Environmental Management Agency (EMA) and an Environmental Impact Assessment Certificate must be approved before any of these operations may commence. As part of the EMA requirements, plans must be submitted outlining how tailings and other waste products will be stored and how the area will be rehabilitated and returned to its original state once the operation is complete.

Environmental Regulations

, All mining activities need to adhere to the regulations of the EMA and obtain an Environmental Impact Assessment Certificate prior to the commencement of operations.

The EMA (Hazardous Substances, Pesticides, and other Toxic Substances) Regulations, 2007, prescribe standards and regulations for hazardous substances and hazardous waste.

The EMA (Control of Alluvial Mining) Regulations, (2014); and the Importation and Transit of Hazardous Substances and Waste, Regulations, 2009; the Environmental Impact Assessment & Ecosystems

Funded by
the European Union

Protection Regulations, 2007; the Effluents and Solid Waste Disposal Regulations, 2007; the Atmospheric Pollution Control Regulations, 2009 and the Control of Hazardous Substances, General Regulations, 2018) provide for the control of alluvial mining, the import and transit of hazardous substances and waste, environmental impact assessments and ecosystems protection, effluents and solid waste disposal, atmospheric pollution control and the control of hazardous substances respectively.

Other licence requirements for the mining sector include Waste Disposal Licences, Effluent Discharge Licences, Emission Licences, and Import/Export Licences for controlled substances. In addition to these, the closure obligations of the holder of a reconnaissance right, exploration right or mining right need to be adhered to, including restoring the land to its original state and removing any hazardous structures, equipment, and disused surface pipes, pump stations, and facilities.

4.1.6. Societal and community aspects, cultural heritage

Zimbabwe has a very rich cultural heritage in terms of its traditions, beliefs, values, languages, arts, crafts, monuments, landscapes, and sacred sites. Though mining can also have positive effects on cultural heritage through provision of economic opportunities and improving the living standards of the communities, mining has been observed to affect Zimbabwe' cultural heritage in several ways that includes:

- Displacing communities from their ancestral lands and disrupting their social cohesion and sense of belonging.
- Destroying or damaging cultural heritage sites, such as historical buildings, archaeological remains, rock art, burial grounds, and sacred places.
- Altering the natural environment and landscape that is part of the cultural heritage of the communities.
- Affecting the transmission and preservation of intangible cultural heritage, such as oral histories, rituals, ceremonies, festivals, and knowledge systems.

Therefore, mining in Zimbabwe should take into account the cultural heritage of the affected communities and ensure that it is respected, protected, and promoted. Mining should also seek to minimize the negative impacts and maximize the positive impacts on cultural heritage. This can be achieved by:

- Conducting comprehensive and participatory cultural heritage impact assessments before starting any mining project.
- Developing and implementing mitigation measures to avoid or reduce the adverse effects on cultural heritage.
- Establishing mechanisms for consultation, dialogue, and grievance redress between the mining companies, the government, and the communities.
- Providing compensation and benefits for the affected communities and ensuring that they share in the profits of mining.

Funded by
the European Union

- Supporting the documentation, safeguarding, and revitalization of intangible cultural heritage among the communities.
- Investing in the restoration, conservation, and enhancement of cultural heritage sites.
- Encouraging the participation and empowerment of the communities in the management and stewardship of their cultural heritage.

4.1.7. Public health and safety

Some of the health issues associated with mining in Zimbabwe include environmental pollution, occupational accidents/injuries and social disruption. Several authored have noted release of harmful substances such as mercury, cyanide, dust and heavy metals into the air, water and soil, affecting the health of workers and surrounding communities. Exposure to these pollutants can cause respiratory diseases, skin infections, neurological disorders, cancer and birth defects. Mudimbu and Meck (2018) conducted a study on the health impacts of artisanal and small-scale gold mining (ASGM) in Zimbabwe and found that most miners and residents reported symptoms that can be attributed exposure to elements released during mining. A considerable number of the CRM bearing pegmatite are located within greenstone belts e.g. the Arcadia lithium project is located within the Harare-Shamva greenstone belt, thus since the pegmatites are intrusive bodies that cut across the greenstone belts the impacts observed by Mudimbu and Meck 2018 are likely to be experienced when mining CRMs.

Zimbabwe has and is still experiencing occupational injuries/fatalities encountered during digging, blasting, crushing, transporting and working underground. These activities can result in mine collapses, explosions, falls, electrocutions, fires and other accidents that can injure or kill workers. According to Singo et al. (2022), the prevalence of accidents and injuries among ASGM workers in Zimbabwe was 35.0% and 25.7%, respectively. The study also identified several risk factors for injuries, such as being male, being 18–35 years old, working long hours and lacking personal protective equipment (PPE). Maponga and Meck 2003 also noted that mining in Zimbabwe was also affecting the livelihoods, culture and well-being of local communities in various ways by displacing people from their land, creating conflicts over resources, increasing migration and prostitution, disrupting traditional norms and values, and reducing social cohesion. These social changes have negative impacts on mental health, family stability, gender relations, human rights and social justice. Leuenberger et al. (2021) explored the community perceptions of health impacts of industrial mining in three sub-Saharan African countries, including Zimbabwe, and found that most participants reported negative impacts such as loss of land, income and identity, increased violence and crime, decreased trust and solidarity, and reduced quality of life.

4.2 Mining practices *vs.* Environmental, Social and Governance (ESG) goals

Zimbabwe's National Development Strategy (NDS1, 2021-2025) highlights that, weak governance in the mine sector is the major limiting factor to the development of the sector. Critical minerals were not explicitly provided for in the current Mines and Minerals Act. The Mines and Mineral Bill (2022) which seeks to the current Mines and Minerals Act [Chapter 21:05] has several objectives including, the

Funded by
the European Union

introduction of the concept of the concept of “strategic minerals” to which special conditions by mutual agreement between the Minister and the State will attach[47]. Under clause 6 the Bill proposes that the Minister should have power, after consultation with the Mining Affairs Board, to declare any mineral to be a “strategic mineral”. Minerals attain special status owing to factors such as short-supply, controls, cost-factor, and strategic utility. In the case of Strategic Minerals, such minerals are important for the defense industry and other strategic industries like energy, nuclear and space.

4.2.1 Environmental challenges

The government requires mining companies to comply with various environmental regulations, including the submission of environmental impact assessments and the implementation of mitigation measures to minimize the impact of mining activities on the environment. Similarly, Mining companies are also required to consider the social impact of their activities and engage with local communities. However, there are very few regulations specifically governing environmental accounting in the Zimbabwean mining sector. The government has not provided enough financial and human resources for research and development of environmental accounting practices, nor have government organizations monitored and controlled the activities of mines in a meaningful way.

4.2.2 Socio-economic issues

The rise in demand for critical minerals and the resultant increase in mining activities within the critical minerals value chain in Zimbabwe present a range of social and environmental risks and challenges that need to be managed. Increasing mining activities can lead to increase carbon emissions, water use, deforestation, environmental pollution, and waste management challenges. These challenges Zimbabwe is already grappling with and the rush for critical raw material is likely to exacerbate this. Furthermore, critical mineral rush without proper environmental impact assessments can adversely affect community livelihoods. Commencing mining without proper mining closure and rehabilitation plans can result in physical environments being left in a state of dereliction, causing a host of ecological, health and safety risks to the community, livestock, and property. Mining and mineral processing activities may also adversely affect the quality of water resources within the mined areas. Thus, adoption of climate-smart mining practices by the Zimbabwe, will avert the negative impacts from increased mining activities that potentially can adversely affect vulnerable communities and the environment, and endanger progress on tackling climate change.

4.2.3 What would be the best practices for a responsible mining?

It is important to adopt best practices for a responsible extraction of CRMs in Zimbabwe that can ensure the sustainability and inclusiveness of the mining sector. Some of the best practices for a responsible extraction of CRMs in Zimbabwe are:

- Domesticating of African Mining Vision (AMV) - a comprehensive framework that fosters sustainable and inclusive development of Africa's mineral resources.

[47] Mines & Minerals Bill.pdf (veritaszim.net)

Funded by
the European Union

- Implementing The African Minerals & Energy Resources Classification and Management System (AMREC) together with the Pan African Reporting Code (PARC) code named AMREC-PARC which is tailored specifically to the African context and aligned with the principles and goals of the AMV and which was developed within the framework of the United Nations Framework Resource Classification (UNFC).
- Implementing the principles and standards of the Extractive Industries Transparency Initiative (EITI), which promotes the disclosure and verification of information on revenues, contracts, licenses, and ownership in the extractive sector. This can enhance the accountability and transparency of the mining industry and prevent illicit financial flows and tax evasion.
- Adopting the guidelines and criteria of the Responsible Minerals Initiative (RMI), which provides tools and resources for companies to identify and address risks in their mineral supply chains. This can help to ensure that the extraction of CRMs does not contribute to conflict, human rights abuses, or environmental harm.
- Applying the framework and indicators of the Sustainable Development Goals (SDGs), which set the global agenda for achieving social, economic, and environmental progress by 2030. This can help to align the extraction of CRMs with the national and regional development priorities and to monitor and evaluate the impacts and outcomes of the mining activities.
- Engaging with the local communities and stakeholders, such as civil society organizations, indigenous groups, women, and youth, who are affected by or involved in the extraction of CRMs. This can foster a participatory and inclusive approach to decision-making and benefit-sharing in the mining sector and to address the grievances and concerns of the affected parties.
- Investing in the capacity building and innovation of the mining sector, such as improving the skills and knowledge of the workers, enhancing the efficiency and safety of the mining operations, diversifying the mineral products and markets, and promoting the circular economy and green technologies. This can increase the competitiveness and resilience of the mining sector and reduce its environmental footprint.

Funded by
the European Union

5 Business network between the European Union and Zimbabwe

There are business networks and trade relations between Europe and Zimbabwe in the minerals sector. Zimbabwe is known for its vast mineral resources and has attracted investment interests from various European countries. The European Union (EU) has been a significant player in promoting business networks between Europe and Zimbabwe in the minerals sector. The EU has been supportive of efforts to enhance responsible mining practices and to stimulate investment in Zimbabwe's mineral industry. The EU has also provided financial assistance for capacity-building programs aimed at improving governance and transparency in the extractive sector. All these are well detailed in the Zimbabwe Multi-Annual Indicative Programme 2012 – 2017.

Additionally, individual European countries, such as Germany, United Kingdom, and France, have established business networks and trade relationships with Zimbabwe in the minerals sector. These networks often facilitate trade and investment opportunities, collaboration on mining projects, and the exchange of technical expertise. Moreover, there is a need to attract more European mining companies to invest in Zimbabwe's mineral sector, particularly in Critical Minerals. These investments have led to joint ventures, technology transfers, and knowledge sharing between European and Zimbabwean companies. Overall, while the business networks between Europe and Zimbabwe in the minerals sector exist, it is essential to consider the context of changing political and economic dynamics that may influence these relationships.

While it is not easy to provide an exhaustive list of all EU-supported mining projects in Zimbabwe, a few examples that have received EU support in the mining sector can be traced. These projects aim to promote responsible mining practices, enhance governance, and support sustainable development in Zimbabwe's mining industry. Here are a few examples:

Zimbabwe Environmental Law Association (ZELA) supported by EU produced a good list of potential and existing lithium minerals projects shown below. The EU has provided support to ZELA, a local civil society organization, to foster more transparent and accountable governance in the extractive sector. ZELA works to promote responsible mining practices and engages in advocacy for sustainable mining policies.

5.1 Assessment of the upstream and downstream business ecosystem

5.1.1 Context, formal and informal players

Funded by
the European Union

In the Zimbabwe mining sector, formal players typically refer to large-scale mining companies or operations that are officially registered with the government and comply with all regulatory requirements. These players often have significant financial resources, employ modern technology and machinery, and adhere to strict environmental and labor standards. Formal players in Zimbabwe's minerals sector include the following: Government-owned mining companies (e.g. Zimbabwe Mining Development Corporation), Large-scale mining companies (local and international), Mineral processing companies, Geological survey and exploration companies, Mining equipment suppliers and manufacturers, Investment and finance institutions involved in mining projects, Regulatory bodies and government agencies (e.g. Ministry of Mines and Mining Development).

This study identified key formal institutions and stakeholders and categorised them into six groups namely: government departments; parastatals; private organizations; mining companies and other stakeholders. These are described in turn as follows:

Government Departments

Several government departments and parastatals are key in the minerals industry. Most of the government departments and parastatals that are directly related to mining fall under the Ministry of Mines and Mining Development (MMMD). The departments are responsible for regulating the minerals sector, administering mining laws, providing mining related services and information on the mining industry. The departments are also responsible for the safety and health inspectorate function as well as reviewing license applications. Some of the government departments and parastatals are discussed below.

- **Department of Metallurgy**:

The Department of Metallurgy, popularly known as the Government Metallurgical Laboratory, monitors and audits mineral processing operations in Zimbabwe. Some of the services provided by the department include extractive metallurgy, physical metallurgy, ceramic metallurgy, analytical metallurgy, monitoring of mineral exports, pollution abatement in the mining and metallurgical industries and applied research in extractive, physical and ceramic metallurgy.

- **Department of Mining Engineering:**

This department is entrusted with providing engineering related services to the mining sector. The Department's roles include monitoring of mining operations; enforcement of mining explosives regulations; mechanical and electrical engineering; ventilation and environmental control; mine survey; and mine engineering. The department is also expected to empower small-scale miners through provision of appropriate technologies and loan facilities. It manages the Mining Industry Development Fund (MIDF) and conducts statutory examinations for the mining industry.

- **Department of Mining Promotion and Mining Development:**

Funded by
the European Union

The major functions of the department include coordinating mineral policy planning and development, promoting investment in the mining industry from both local and foreign investors, monitoring and supervising the performance of mining parastatals and state companies. The department is also expected to compile and analyse national mineral production statistics, monitor marketing of minerals (including imports of minerals and minerals bearing products into the country). The other tasks for the department include keeping an up to date record of new and old mines about their production levels, employment and revenue trends as well as evaluating possibilities for the development of value added processing of minerals. This department is also responsible for the development of small-scale mining into medium or large-scale mining enterprises.

- **Department of Mining Promotion and Mining Development:**

The major functions of the department include coordinating mineral policy planning and development, promoting investment in the mining industry from both local and foreign investors, monitoring and supervising the performance of mining parastatals and state companies. The department is also expected to compile and analyse national mineral production statistics, monitor marketing of minerals (including imports of minerals and minerals bearing products into the country). The other tasks for the department include keeping an up to date record of new and old mines about their production levels, employment and revenue trends as well as evaluating possibilities for the development of value added processing of minerals. This department is also responsible for the development of small-scale mining into medium or large-scale mining enterprises.

- **Department of Mining Promotion and Mining Development:**

The major functions of the department include coordinating mineral policy planning and development, promoting investment in the mining industry from both local and foreign investors, monitoring and supervising the performance of mining parastatals and state companies. The department is also expected to compile and analyse national mineral production statistics, monitor marketing of minerals (including imports of minerals and minerals bearing products into the country). The other tasks for the department include keeping an up to date record of new and old mines about their production levels, employment and revenue trends as well as evaluating possibilities for the development of value added processing of minerals. This department is also responsible for the development of small-scale mining into medium or large-scale mining enterprises.

- **Department of Mining Law and Administration:**

The Department of Mining Law and Administration is also referred to as the legal services department. Its major role is to enforce the provisions of the Mines and Minerals Act (Chapter 21:05) and other appropriate legislations. It is also responsible for granting mining rights, registration of custom millers, initiating legislation and recommending amendments, presiding over miner/ farmer and miner/ miner disputes and keeping an accurate database for all registration, cancellation and production. Curbing of leakages of gold/ precious stones is also one of this department's mandates. The department also offers legal services to the Ministry.

Funded by
the European Union

- **Department of Geological Survey:**

Mapping the geology of the country and generating information on mineral resources potential of the country are the major tasks of the Department of Geological Survey. However, this department also provides technical, consultative and advisory services on mining geology and mineral exploration to the industry and small-scale miners. It also provides the public with information on mineral exploration and exploitation, collates and archives national geological information, and maintains current and potential mineral deposit databases.

Parastatals

The three parastatals regarded as stakeholders for the minerals industry are Zimbabwe Mining Development Corporation (ZMDC), Minerals Marketing Corporation of Zimbabwe (MMCZ) and Fidelity Printers and Refiners. The first two falls under MMMD whilst the last falls under the Reserve Bank of Zimbabwe.

- **Mineral Marketing Corporation of Zimbabwe:**

Minerals Marketing Corporation of Zimbabwe (MMCZ) was established in 1983 and is an exclusive agent for marketing and selling of all minerals produced in Zimbabwe except silver and gold. It also provides advisory services, promotion of investments in mining related activities and national mineral resource accounting. The Corporation searches for markets on behalf of producers, negotiates, enters and administers the implementation of sales agreements on behalf of the customers. It is also responsible for the physical movement of the product from the mine location to the point of sale. The mineral resource accounting throughout the value chain, that is, from extraction of ore up to the final sale of the product is conducted by the MMCZ inspectorate division. MMCZ also has projects, which include chrome ore claims, gold project, gold roasting plant, granite claims and a diamond cutting and polishing factory.

- **Zimbabwe Mining Development Corporation:**

Zimbabwe Mining Development Corporation (ZMDC) was established in 1982 by an Act of Parliament to engage in prospecting, exploration and mining on behalf of the Government. Through its ownership of various mines around the country, it is involved in mining of diamonds, gold, platinum, graphite, emeralds, tin, copper and asbestos. It also has joint ventures with other mining houses for diamond, platinum, uranium and graphite mining.

- **Fidelity Printers and Refinery:**

Fidelity Printers and Refinery is a security printing and gold refinery company wholly owned by the Reserve Bank of Zimbabwe. It produces all security documents including currency, passports, examination papers, travellers' cheques, Commercial Bank cheques, passbooks and a wide range of other government security documents. The mining related aspect of Fidelity Printers and Refinery is the refining of gold and silver. Whilst all the other minerals are sold through MMCZ, Fidelity Printers and Refinery is the sole authorised buyer and exporter of gold in Zimbabwe.

Funded by
the European Union

Private Organisations

- **Chamber of Mines of Zimbabwe:**

The Chamber of Mines of Zimbabwe (CoMZ) is a private sector voluntary organization established in 1939 by an Act of Parliament. Its primary objectives Zimbabwe Economic Policy Analysis and Research Unit (ZEPARU) 23 are to advocate and lobby in order to promote, encourage and protect the interests of the players in the mining industry in Zimbabwe.

- **Geological Society of Zimbabwe:**

The Society is a body corporate under the common law of Zimbabwe. Its objectives are to promote the science and practice of geology and execute all issues conducive to the advancement of earth science. It thus promotes geological research, teaching, exploration and mining in Zimbabwe. It acts as a forum to exchange knowledge and practices on geological issues.

- **Association of Mine Surveyors of Zimbabwe:**

The association provides professional representation to government, industry and educational organisations on mine surveying issues. Some of its objectives are to promote interest in mine surveying, advance the science and practice of mine surveying, establish a system of grading of mine surveyors in relation to their qualifications and promote mutual interest with allied disciplines. The association is affiliated to the Chamber of Mines of Zimbabwe.

- **The Association of Mine Managers of Zimbabwe:**

This is an association of qualified people who are, or have been, employed in senior operational positions in the mining industry. The association discusses matters of common interests, and its members attend and participate in technical seminars to maintain competencies, provide support to peers and influence industry outcomes. It promotes the study of mining and allied disciplines and has representation in Zimbabwe School of Mines Academic Board, Chamber of Mines of Zimbabwe and the Board of Examiners for the Full Blasting Licenses and Mine Manager's Certificate of Competences

Mining Companies formal and informal

It's important to note that both formal and informal players play distinct roles in the Zimbabwe mining sector, and efforts are being made to formalize and regulate informal mining activities while ensuring that formal mining operations operate responsibly and sustainably.

Informal players, on the other hand, usually consist of small-scale miners, artisanal miners, and unregistered mining operations. They may operate without official permits, use rudimentary tools and methods, and often work in remote or unregulated areas.

Funded by
the European Union

Zimbabwe is noted for its unique geology which is host to a variety of economic minerals. The number of mining companies in Zimbabwe is estimated at between 800 and 900 (Jourdan et al, 2012)[48]. Most of the mining companies are members of the Chamber of Mines. However, many companies are small and artisanal companies owing to the nature of the deposits they exploit, which in most cases are small

Zimbabwe hosts a sizeable number of Artisanal and small-scale miners (ASM) with the number of artisanal and small-scale miners is estimated to be 500,000 (Kahwai, 2013)[49]. There are other mining syndicates and cooperatives, local communities involved in small-scale mining activities, unregistered traders of minerals and unregistered mining. These are also members of small scale miners associations, which include Zimbabwe Artisanal and Small Scale for Sustainable Mining Council (ZASMC), Zimbabwe Women in Mining, Gold Miners Association of Zimbabwe (GMAZ) and the Zimbabwe Miners Federation.

While informal players may contribute significantly to the overall production of minerals, their activities can also be associated with environmental degradation, unsafe working conditions, and lack of proper legal protections for workers.

Other Stakeholders

There are other stakeholders whose operations directly affect or are directly related to the mining industry. These include the Zimbabwe National Water Authority(ZINWA), Environmental Management Agency(EMA), Parliamentary Portfolio Committee on Mines and Energy, Rural District Councils (RDC), Standard Association of Zimbabwe (SAZ) and suppliers of mining equipment and consumables. Mining activities are also required to commence with the knowledge and approval of RDCs. There are other stakeholders whose operations directly affect or are directly related to the mining industry. These include the Zimbabwe National Water Authority(ZINWA), Environmental Management Agency(EMA), Parliamentary Portfolio Committee on Mines and Energy, Rural District Councils (RDC), Standard Association of Zimbabwe (SAZ) and suppliers of mining equipment and consumables.

6 Informal players, on the other hand, usually consist of small-scale miners, artisanal miners, and unregistered mining operations. They may operate without official permits, use rudimentary tools and methods, and often work in remote or unregulated areas. While informal players may contribute significantly to the overall production of minerals, their activities can also be associated with environmental degradation, unsafe working conditions, and lack of proper legal protections for workers.

7 It's important to note that both formal and informal players play distinct roles in the Zimbabwe mining sector, and efforts are being made to formalize and regulate informal mining activities while ensuring that formal mining operations operate responsibly and sustainably.

[48] Jourdan P, Chigumira G., Kwesu I., Chipumho E. (2012). Mining Sector Policy Study, Zimbabwe Economic Policy Analysis and Research Unit (ZEPARU), Harare.
[49] Kahwai S (2013), Opportunities in the Mining Sector, Presentation made during a workshop organised by the Ministry of Higher and Tertiary Education on Diaspora Engagement, Double Tree Hotel, Dallas, Texas 25 May 2013

Funded by
the European Union

5.1.2 Relationships at local or regional levels

The EU's engagement in the Green Economic Growth Priority Area is also taking place in the context of negotiations to conclude a comprehensive and more ambitious Economic Partnership Agreement (EPA) with Zimbabwe together with the other five, Eastern and Southern African (ESA) countries who signed the interim EPA. This provides for trade and investment opportunities between EU and Zimbabwe as well as between Zimbabwe in the critical minerals. The promotion of investment in Africa is a topical issue now also in the context of the African Continental Free Trade Area (AfCFTA). Zimbabwe is a member of Common Market for Eastern and Southern Africa (COMESA) and Southern African Development Corporation (SADC).

The relationships at local and regional levels for the Zimbabwe minerals sector are influenced by various factors, including Zimbabwe's signing of the Economic Partnership Agreement (EPA) with the European Union under the Eastern and Southern Africa (ESA-EPA) framework. As a member of Regional Economic Communities (RECs) such as the Southern African Development Community (SADC) and having ratified the African Continental Free Trade Area (AfCFTA) agreement, Zimbabwe's minerals sector is interconnected with regional and continental trade dynamics.

At the local level, the mining industry in Zimbabwe is impacted by government policies, regulatory frameworks, and local community engagement. The relationships between mining companies, local communities, and local authorities play a significant role in shaping the overall dynamics of the minerals sector.

On a regional level, Zimbabwe's participation in the SADC framework influences trade, investment, and cooperation in the minerals sector with other SADC member states. The SADC Protocol on Mining and the SADC Free Trade Area framework as well as SADC Industrial Development Strategy and Master Plan contribute to regional trade dynamics for minerals, impacting Zimbabwe's relationships with its neighbors. Furthermore, the ratification of the AfCFTA agreement creates additional opportunities and challenges for Zimbabwe's minerals sector. It opens up the potential for increased trade in minerals within the African continent, leading to partnerships and collaborations with other African countries in the mining industry.

Overall, the relationships at local and regional levels for the Zimbabwe minerals sector are shaped by a complex interplay of policy frameworks, trade agreements, and collaborative efforts within the local and regional contexts.

5.1.3 Overview of the local or regional clusters

There are several local mining clusters in Zimbabwe, with the most prominent ones being in the regions of Mashonaland Central, Mashonaland West, and Midlands. These clusters are known for their rich deposits of gold, platinum, diamonds, and other minerals.

Moreover the Southern African Development Community (SADC) region has several mining clusters for critical minerals, some of which are linked with Zimbabwe. The main regional mining clusters in the SADC region include:

- Copperbelt in Zambia and Democratic Republic of the Congo (DRC): This region is known for its large copper reserves, and some of the minerals extracted here are critical for various industries.

Funded by
the European Union

- Bushveld Complex in South Africa: This area is rich in platinum group metals (PGMs) and chromium, which are critical minerals used in various industrial applications.
- Matabeleland in Zimbabwe: This region is known for its rich deposits of gold, platinum, and other critical minerals, making it an important mining cluster in the SADC region.
- Kibara Belt in Tanzania and DRC: The Central African Mesoproterozoic Kibara belt in Katanga (DRCongo) and Karagwe (Tanzania) forms a metallogenic province that hosts a variety of granite-related mineralization, rich in cassiterite, columbite–tantalite, wolframite/ferberite, spodumene and beryl. This region is also rich in graphite and lithium'.

These mining clusters are important for the extraction of critical minerals in the SADC region and are often linked with Zimbabwe due to the country's significant mineral reserves and mining activities.

5.2 Building new B2B relations

Building new B2B relations in the Zimbabwe mining sector requires a strategic approach and includes gaining a comprehensive understanding of the Zimbabwe mining industry, the key players, mining regulations, current projects, and potential opportunities etc. It also requires attending industry events and conferences: participate in mining conferences, trade shows, and networking events in Zimbabwe. These events provide an excellent platform to meet industry professionals, potential partners, and government officials. The following examples are some of the key events in Zimbabwe:

- **Chamber of Mine annual mining conference & golf tournament:** This is an annual event that provides a platform for industry leaders, government, investors and financiers opportunity to interact and discuss key matters relevant to the development of the mining industry.
- **Mining industry supplier's forum:** This platform brings mining companies, suppliers and other related industries to discuss pertinent issues related to the entire mining value chain, including enhancing linkages in the mining industry.
- **Chamber of Mines jumbo golf tournament:** The Jumbo Golf tournament is a prime golfing tournament is a prime golfing tournament targeting the mining industry. It is an event that provides the opportunity for networking and building relations. There are also other golf tournaments held by individual mines during the course of the year that can be of key importance in b2b networking.

There are other events that are key for networking and provide opportunity to engage in conversations, exchange contact information, and meet or follow up with interested parties.

It is also vital to leverage on local business networks by tapping into local business networks and industry associations in Zimbabwe already mentioned in this study. These organizations can provide valuable insights, introductions, and support in navigating the local business landscape. Join relevant associations, attend their meetings, and actively participate in their activities and establish relationships with key stakeholders: Identify key stakeholders in the Zimbabwe mining sector, such as mining companies, suppliers, contractors, and government agencies alluded to earlier.

Funded by
the European Union

5.3 Promoting local content and enabling mining cluster actors

Zimbabwe hosts a number of institutions that are key to building national local content and enabling mining clusters

Relevant institutions for the development of a Zimbabwe-focused critical minerals network

Tertiary institutions

There are several tertiary institutes offering training for the minerals industry and these include universities, polytechnic colleges, government institutes and independent institutions.

- **Universities**

Among the universities that offer tertiary education relevant to minerals industry are Midlands State University, University of Zimbabwe, and Bindura University of Science and Technology.

Midlands State University offers degrees in Chemical and Processing Engineering, Mining and Mineral Processing Engineering, Surveying and Geomatics. The departments that offer mining related degrees at the University of Zimbabwe are Mining Engineering, Metallurgy, Geoinformatics and Geology. At the Bindura University of Science and Technology, the Earth Science Department offers mining related degrees.

- **Institute of Mining Research**

The role of the institution is to enable the sustainable development of mining and related sectors in Zimbabwe through innovative and responsive research, further education, training and consultancy services. The mining community may also obtain advice and assistance by utilising the extensive facilities of the Institute of Mining Research, which is partially funded by government. The institution carries out research in mineral economics, mineralogy and metallurgy.

- **The Zimbabwe School of Mines**

This training institution was established by a Presidential Charter in 1994 although its existence dates back to 1926. Its mandate is to provide technical education and practical training for people who wish to enter the mining industry. The school provides in-house training services for professional mining personnel, mining related information and consultancy services to industry. It also offers distance learning and assists Government in manpower planning and development as is related to mining and related industries. The school is a regional institution that serves the SADC mining industry. It offers competency-based training and hands-on mining courses and support services. Several stakeholders among them the University of Zimbabwe, Chamber of Mines and Geological society are involved in the curriculum development and quality of training at the institute

- **Zimbabwe Institute of Legal Studies**

The Zimbabwe Institute of Legal Studies (ZILS) is an independent institution offering skilled manpower and vocational training for the law and forensic science. Their one year certificates and three year

Funded by
the European Union

diplomas in Mineral law and Policy are mining related thus making the institution a stakeholder for minerals sector.

- **The Zimbabwe Diamond Education College**

The Zimbabwe Diamond Education College, which was established in 2010 as a direct response to the discovery of diamonds in Zimbabwe, provides knowledge and skills to enter the diamond industry. Its mission is to impart skills for the diamond industry, add value to the diamond industry, encourage investment, empower Zimbabweans and reduce unemployment. It is also involved in defining unit standards for evaluating proficiency in the various aspects of the diamond industry as well as make links with the outside world. The college also organises workshops for various stakeholders on awareness and aims to influence policy.

- **Polytechnics**

The polytechnic colleges dotted around the country offer engineering courses that are relevant to mining. The Kwekwe Polytechnic, which is located in Midlands, one of Zimbabwe's richest provinces in terms of minerals, has tailormade courses which are designed to help small scale and artisanal miners who constitute the bulk of this gold mining province but who also engage in other minerals.

Funded by
the European Union

6. Energy and digital transition: develop a strategy for the EU and Africa Partnership

The AfricaMaVal project aligns with the strategies that aim to achieve Zimbabwe's Vision 2030, as well as the global goals of the Sustainable Development Goals (SDGs) and Africa Agenda 2063. These strategies focus on finding local alternatives to imports by developing local value chains based on Zimbabwe's own strengths. The effective implementation of the country's development agenda relies on the wise use of mineral resources, which are essential for other countries' responsible sourcing. Therefore, it is important to ensure that local co-development is sustainable and follows the best Environmental, Social and Governance standards.

The mining sector of Zimbabwe is one of the key drivers of growth, along with the agriculture sector. Hence, the need for Zimbabwe to leverage its mineral resources for growth and development is urgent. This requires a comprehensive assessment of the whole mining sector value chain. In 2018, the Government of Zimbabwe launched a national modernization and industrialization program to achieve an Empowered and Prosperous Upper Middle-Income Economy by 2030 (Vision 2030). To this end, the Government developed the National Development Strategy 1 (NDS1) a 5-year Medium Term Plan for the period 2021-2025, and is in the process of crafting NDS2 for the period 2026-2030. These plans aim to realize the country's Vision 2030, while also addressing the global goals of the Sustainable Development Goals (SDGs) and Africa Agenda 2063.

The National Priority Areas for Zimbabwe as it strives to become an upper middle-income society by 2030 include: Governance; Value Chains and Structural Transformation; Environmental Protection, Climate Resilience and Natural Resource Management; and Social Protection. The country's policy direction is to increase investment in the mining sector to achieve a US$12 billion mineral economy by 2023.

The government is also promoting mineral value addition to transform the economic structure of the country from one highly dependent on the export of minerals and agricultural raw materials to an economy trading high value processed goods.

Funded by
the European Union

7. Opportunities for responsible investments

The country's policy thrust is to boost investment in the mining sector to achieve US$12 billion mineral economy by 2023. The government is also promoting mineral value addition to transform the economic structure of the country from one highly dependent on the export of minerals and agricultural raw materials to an economy trading high value processed goods.

Exploitation of critical minerals are poised to play a significant role in national security, economy, renewable energy development and infrastructure. Minerals such as aluminium, lithium, copper, nickel, and rare earths are critical minerals whose extraction, beneficiation and value addition will play a pivotal role in the economic development and transformation of Zimbabwe. Graphite and lithium for example are critical whose demand will depend on the requirements for battery storage in the low carbon transition. Furthermore, critical minerals that are both "high-impact" and "cross-cutting" will be used in a wide range of technologies and a great amount of them will be required to meet projected demand in a low-carbon world. Manganese is another critical mineral present in Zimbabwe which is increasingly being used as a lower-cost substitute to some other metals in battery chemistry. It is also used to improve steel quality. Increased foreign investment interest in critical minerals, high prices and strong global demand for critical minerals are defining the investment dynamics in these minerals in Zimbabwe.

Apart from investment in extraction of ore, government's investment thrust is also on beneficiation and value addition of extracted minerals. For example, the platinum mining process entails extracting the ore from the ground and crushing it. The crushed ore is typically processed using a flotation system to separate platinum bearing rock from waste rock. This platinum matte is concentrated, and then sent to a refinery for smelting in South Africa. In 2019 Zimbabwe opened at the Unki Mine to facilitating smelting of platinum within the country.

Platinum is highly recyclable, and as products, which contain platinum or other platinum group metals (PGMs) reach their end-of-life, the PGM-content can be extracted through a process of smelting and refining. Thus, **investment in building smelting and refining capacity within the country** facilitates growth of the circular economy. The circular economy advocates designing products to be more durable, repairable, and recyclable, maximizing the reuse of materials and therefore ensuring they are kept in circulation for as long as possible. It seeks to reduce waste and reinforces the importance of managing impacts and consuming fewer resources to deliver sustainable outcomes, lowering both demand for raw materials and the environmental impact associated with obtaining them. Sustainable metals management and the recycling of PGM-containing end-of-life products is becoming an increasingly important focus where platinum is used in the technological solutions needed to combat climate change. As these are scaled up, there is a growing emphasis on the need to ensure that the critical minerals required are supported by manufacturing processes and supply chains that are "circular" (World Platinum Investment Council, 2023) .

Investing in Zimbabwe's mining sector presents a promising opportunity for businesses and investors seeking to tap into the country's rich natural resources and growing economy. The thrust of Vision 2030 and one of the objectives of NDS1 is to accelerate beneficiation and value addition and move away from

Funded by
the European Union

exports of raw and semi-processed minerals. **Eight minerals targeted for beneficiation** are platinum, chrome, lithium, nickel, diamond cutting and polishing, copper, gold, and coal, with strengthening of linkages along the mineral value chain.

The NDS1 highlights the need to **invest in value addition to transform Zimbabwe's economic structure** from one highly dependent on the export of mineral and agricultural raw materials to an economy trading high value processed goods. To achieve increased and sustained growth in the mining sector, priority within NDS1 Period has been placed on improving the ease of doing business in the mining sector.

The NDS1 highlights that, Zimbabwe has 19 of the world's rare earth minerals. To designate these strategic assets and direct investment into their exploitation, the Government pronounced that it would expedite the formulation of Rare Earth Minerals Policy during the NDS1 period. Table 20 shows Government's envisaged economic transformation which can arise through investment in industrial processing and production of goods and services from rare earth resources such as neodymium, lanthanum, cerium, praseodymium, and gadolinium, among others. Manganese is increasingly being used as a lower-cost substitute to some other metals in battery chemistry.

Rare Earth Mineral	Uses
Neodymium	Used in the manufacture of powerful magnets, computer hard drives, wind turbines and hybrid cars
Lanthanum	Used in the manufacture of carbon lighting applications such as cameras and telescope lenses
Cerium	Used in the manufacture of catalytic convertors and some crude oil refining
Praseodymium	Used in the manufacture of aircraft engines and special glasses
Gadolinium	Used in X-ray and MRI scanning systems and manufacture of refrigerators which do not emit greenhouse gasses such as CFC's or chlorofluorocarbons
Yttrium, Terbium, Europium	Used in the manufacture of memory chips for computers, televisions, and other visual display devices, which different colors. Europium was also important in the manufacture of control rods used in nuclear reactors.

Table 21 Rare mineral value chains targeted by Zimbabwe government[50]

The GoZ (2018) also highlighted that effective exploitation of Zimbabwe's diverse underground mineral resource endowment will be enhanced through concerted investment in geological surveys and mineral exploration. Investment opportunities outlined on the Zimbabwe Investment Development Agency (ZIDA) in the mining sector includes extraction of gold ore to bullion processing; cutting diamonds; base metal (nickel, copper, iron, and cobalt), recovery from the platinum group of minerals (PGMs), Coal to Coke; Phosphate to fertilizer; and Chrome to ferrochrome.

[50] Source: Government of Zimbabwe 2020 p. 105

Funded by
the European Union

Lithium which has attracted world attention as a critical mineral in production of electric vehicles (EV) and other clean technologies gadgets presents has recently emerged as a major investment opportunity in Zimbabwe.

Cabinet recently approved the Lithium Ore Policy and issued Statutory Instrument 57 of 2023, based on the following principles:

1. Any individual or entity owing a lithium concession can mine lithium ores for either: (i) processing at its own Approved Processing Plant (APP), or (ii) for sale to those with Approved Processing Plants locally.

2. Any individual and or entity wishing to process lithium ores will be required to construct an Approved Processing Plant locally;

3. Ore movement permits for lithium ores will only be issued where such ores are destined for a local Approved Processing Plant;

4. Lithium ores can only be stored at the mining site where such ores were mined, or at an approved for local Approved Processing Plant;

5. Any entity will require a Lithium Ore Purchase License to buy ores from miners. A local Approved Processing Plant will be a condition for obtaining the Lithium Ore Purchase License.

6. all players in the lithium sector, whether miners or holders of Approved Processing Plant, shall submit a summary of monthly reconciliations of ore movements to the Ministry of Mines and Mining Development; and

7. For any material to qualify as a concentrate for approval for export, it shall meet the minimum set technical specifications and the minimum selling price as set by the Minerals Marketing Corporation of Zimbabwe on a regular basis

Zimbabwe is burgeoning lithium hub with several lithium mining and processing projects that are at various stages of development (see section 2). Increased participation in lithium production provides huge opportunities for Zimbabwe to participate in the lithium value chain not only through the EV but other renewable energy projects that require storage facilities in the form of lithium batteries. Further, through lithium production, there is scope for technology transfer to Zimbabwe that would boost lithium processing capacity locally.

The Zimbabwe investment Authority (ZIDA) is **targeting to mobilize US$4bn in foreign direct investment** by end of 2023. ZIDA's investment promotion is leveraging on Zimbabwe's vast mineral resources and the Government's beneficiation and value addition policy especially on Lithium. The Government policy on beneficiation and value addition is expected to influence investors to direct capital into plants and equipment for beneficiation. For example, investors in the lithium sector are committing resources in beneficiation as evidenced by the commissioning of the Prospect Lithium Zimbabwe spodumene, Platinum and tantalum processing plant with a total capacity of 4.5 million tonnes per year (The Herald, 2023). ZIDA is also targeting in its investment promotion resource and market seeking investors. Resource

Funded by
the European Union

seeking investors have been identified to be mostly from European and Asian markets, with a focus on renewable resources uptake and mineral extraction. The strategy is focused on licensing investors to develop and operate within Zimbabwe and add value to the resources extracted (Financial Gazette, 2023).

Financial instruments and investment funds

Depending on the scope of the critical minerals mining project there are **several funding options that can be explored** including loan/debt and equity financing.

Applicants to issue equity on the United States Dollars denominated Victoria Stock Exchange require a minimum subscribed capital of USD3 million (not less than 10m shares); satisfactory profit history for the preceding 3 years; at least 30% of the shares to be held by the public; minimum number of shareholders a) 50 in respect of equity shares; b) 25 in respect of preference shares; c) 10 in respect of debentures.

Furthermore, blended financing options, which combine concessional public finance with non-concessional private finance and expertise from the public and private sector, special-purpose vehicles, non-recourse project financing, risk mitigation instruments and pooled funding structures can also be utilized.

7.1 Identification of individual exploration, mining and refining projects

Each project to be proposed was supposed to fulfil the following minimum requirements..

- **Credible ECRM resource estimate available**;
- **Sufficient availability of credible project-specific information on economics and ESG features**. This typically refers to studies such as scoping studies, preliminary economic assessments, pre-feasibility and feasibility studies (JORC, NI43-101, PERC, SAMREC, CIM, SME, etc.-compliant as far as possible), environmental and social impact assessments, permit details and supporting documents, company reports containing project-specific information, credible internal reports (that may not be published) or credible third party reports (e.g., independent audits);
- **The project operator is seeking investment or financing**;
- **Part of the project's current or anticipated future ECRM production is potentially available to the EU industry**.

Obtaining detailed information to be presented as fact sheets has been challenging as most companies are not willing to volunteer information which is not public. Some of the information mount to conducting due diligence that can only be conducted through a B2B process yet some of the information can be sensitive and protected under the confidentiality clauses of agreements with the Government.

Notwithstanding, for Zimbabwe, many local owners of lithium projects in early development stages have promising economic prospects, but lack the financial means to conduct scoping studies, preliminary economic assessments and data collection for code compliant resources. Though these projects do not

Funded by
the European Union

have reliable ECRM resource estimates, mining and production activities are ongoing and potential is significant. These small-scale miners are looking for investment to enhance their production and ESG performance. These small-scale mines could be attractive for European industry off takers. AfricaMaval can assist in securing such projects. The following example projects are suggested for AfricaMaVal WP7 presentation. This suggestion is based on the observation that small scale miners, rather than large scale mines, are operating lithium projects in Zimbabwe.

Project	Operator	Commodity	Address/contact	Location	Status	Reserves/ Resources
Rudolphia	Jelous Hlanganiso	Lithium	Dean Matienga	36K UTM 0230000,8038000	Mining ongoing	Data not made public
Eunice II	Jelous Hlanganiso	Lithium		36K UTM 0326680,803822	Mining ongoing	Resource not made public

Table 22 Info on projects to be presented as opportunities for investments in Zimbabwe

7.2 ASM sector country profiles

According to Chimonyo *et al* 2020, Moyo & Chambati 2013, Spiegel & Mwita and Zimunya & Dube 2019 the artisanal and small-scale mining (ASM) sector in Zimbabwe is a significant contributor to the country's economy.

The overall ASM sector is estimated to employ at least 1.5 million people in Zimbabwe and the sector remains largely informal with few mining organizations officially registered and recognized as formal entities. The ASM sector is largely focused on gold production (representing 70% of the sector), in addition to other commodities such as chromium or semi-precious stones. Minerals like tin, tantalum and tungsten have records of past production, but less information on more recent activities is available. However, the increased market demand and prices of lithium, led to a rise of the ASM sector involvement in lithium production, although larger scale production of lithium had been occurring for several decades. Reportedly, the lithium rush has led many ASM miners to move to lithium mining, however the sector has faced challenges in accessing formal markets. The government ban on raw lithium ore and base metals exports, put in place as an effort to retain value from minerals mined in Zimbabwe, based on stakeholders' observations has exacerbated the informality of the sector, leading to increased smuggling and trade through informal channels. As a result, greater capturing of lithium production by the ASM sector and access to value addition facilities have been raised as points of attention. The government has expressed its intention to formalize the ASM sector and provide a systematic governance framework that recognizes its strategic value and potential for sustainable development. The ASM sector also needs to improve its safety, health and environmental standards, as well as its linkages with other actors in the mining industry such as large-scale miners, traders, brokers, service providers and regulators.

A comprehensive overview on the ore deposits and production parameters of ECRMS currently recovered by artisanal and small-scale mining in Africa is already available as part of the AfricaMaVal deliverable 1.4.

Funded by
the European Union

While a more detailed analysis of the ASM sector role in the production of ECRMs in Zimbabwe, including major challenges and investment opportunities on production, social, governance and environmental impacts and value chain, will be available as part of AfricaMaVal deliverable 7.2.

The artisanal sector is at present illegal and thus not regulated, yet the Government has been considering developing an Artisanal and Small-Scale Mining Policy. Experience in other minerals such as gold in Zimbabwe and other African countries (DRC and Tanzania) has shown that artisanal mining in resource-rich areas has great development potential and criminalising it is counterproductive. Regulated artisanal mining would benefit local community livelihood but it needs to be properly managed and implemented with the lessons learned from artisanal mining from other minerals and countries. **An effective framework should have the right balance between regulating and supporting miners to collectively improve responsible mining practices, working conditions, environmental impact, and payment of taxes.** The Government will also have to facilitate the development of infrastructure and human resource to ensure a transparent traceability of the newly artisanally-mined lithium supply-chain. This is a potential area that can be supported by EU in order to increase ASM mined minerals accessing the EU market.

Funded by
the European Union

Conclusions

Zimbabwe has the potential to produce several ECRM that includes Beryllium, Fluorspar, Lithium, Magnesium, Manganese, Niobium, PGMs, Antimony, Tantalum, Tungsten as well as other important metals like Copper, Nickel and Tin. Prospectivity and mineral high potential mapping was used in this study as a tool for CRMs assessment. Geological, geochemical, geophysical and remote sensing data was used to identify and rank areas that have a higher likelihood of hosting CRMs in Zimbabwe and the maps produced provide valuable information for land use planning, environmental management and mineral policy development.

Zimbabwe has some existing ore processing and refining capacities for CRMs, but they are not sufficient to meet the domestic and regional demand. However, the existing capacities can be leveraged on if someone wishes to venture into CRMs mining in Zimbabwe.

According to the Fraser Institute, Zimbabwe ranks low in terms of investment attractiveness and policy perception for the mining sector, indicating a need for improving the regulatory and fiscal environment. The World Governance Indicators also show that Zimbabwe performs poorly on measures of political stability, rule of law, corruption and government effectiveness. The Logistics Performance Index suggests that Zimbabwe has room for improvement in terms of infrastructure, customs, tracking and timeliness of trade. The Zimbabwe Economic Policy Analysis and Research Unit (ZEPARU) observes that the exploitation and beneficiation of CRMs in Zimbabwe face several challenges, such as data gaps, governance risks, environmental and social impacts, and limited value addition. Some of the data gaps identified by ZEPARU include the lack of reliable and updated geological information, the lack of transparency and accountability in the mining sector, and the lack of data sharing and coordination among different stakeholders. Some of the governance risks include the weak regulatory framework and enforcement capacity, environmental impacts of mining activities, and social conflicts. On the other hand, ZEPARU has identified several potential benefits of developing the critical minerals value chain, such as diversifying the economy, creating jobs, enhancing value addition, attracting foreign direct investment and increasing export earnings. ZEPARU also recommends that Zimbabwe should pursue strategic partnerships with regional and global actors, such as the Mineral Security Partnership, the European Union and China, to access markets, technology and finance for its critical minerals sector. Moreover, Zimbabwe should adopt responsible sourcing initiatives and high environmental and social standards to ensure that its critical minerals production is sustainable and inclusive of local communities

Though, the macroeconomic context for critical raw material financing in Zimbabwe is challenging it is definitely not hopeless. The country faces high inflation, low growth, fiscal deficits, debt distress, and currency instability, which undermine investor confidence and limit access to external financing. However, the government has taken some steps to reform its economic policies, such as adopting a new currency regime, implementing a staff-monitored program with the IMF, and engaging with creditors and donors. Moreover, the country has abundant natural resources, especially in the mining sector, which could attract foreign direct investment and generate export revenues. With the current efforts to address its

Funded by
the European Union

macroeconomic imbalances, improve its business environment, and strengthen its governance and institutions, Zimbabwe can unlock its potential for critical raw material financing and development.

Zimbabwe is currently facing a number of social, environmental, and governance challenges that hinder its progress towards sustainable development. Some of the major challenges include deforestation, climate change, air and water pollution, land degradation, biodiversity loss, soil erosion, invasive species, overgrazing, habitat destruction, waste management, and pollution from mining. These challenges have negative impacts on the health, well-being, and livelihoods of the population, as well as on the natural resources and ecosystems that support them. Ongoing efforts to address these challenges, include strengthening of its institutional and legal frameworks, enhancement of capacity and coordination for environmental management, promoting participatory and inclusive approaches, fostering innovation and technology transfer, and leveraging partnerships with various stakeholders. Thus, there are ways Zimbabwe is endeavouring to overcome its social, environmental, and governance challenges and achieve its Vision 2030 and the 2030 Agenda for Sustainable Development.

Funded by
the European Union

References

Bartholomew D S. (1996) Base Metal and Industrial Mineral Deposits of Zimbabwe. Geological Survey of Zimbabwe. Mineral Resources Series No. 22

Buchholz, P., Oberthur, T., Luders, V., Wilkinson, J. (2007) Multistage Au-As-Sb Mineralization and Crustal-Scale Fluid Evolution in the Kwekwe District, Midlands Greenstone Belt, Zimbabwe: A Combined Geochemical, Mineralogical, Stable Isotope, and Fluid Inclusion Study. Economic Geology, 102 (3). 347-378 doi:10.2113/gsecongeo.102.3.347.

Champion, D. (2019). Australian Resource Reviews: Tantalum. Geoscience Australia, Canberra. http://dx.doi.org/10.11636/9781925848298

Carbajal Glass, F. 2022. Preventing Environmental Crime and Human Vulnerability through the MGPOC Framework: The Case of Zimbabwe's Lithium Industry. Journal of Illicit Economies and Development, 4(1), pp. 34–43. DOI: https:// doi.org/10.31389/jied.141

Chigumira. G, N. Mupunga and E. Chipumho (2018), An Assessment of Arrears Clearance and Sustainable Debt Options for Zimbabwe. An assessment of arrears clearance web (1).pdf (zepari.co.zw)

Chimonyo, S., Makoni, T., & Muzerengi, C. (2020). Artisanal and small-scale mining governance in Zimbabwe: Analysis of the legal and policy framework. The Extractive Industries and Society, 7(4), 1468-1478.

DeVere Zimbabwe (2023). Foreign Currency deposits in Zimbabwe Soar. Available at: https://www.devere-zimbabwe.co.zw/news/Foreign-currency-deposits-in-Zimbabwe-soar

Du Toit A (1998) The Economic Geology of the Country around Kwekwe. Available at: https://books.google.com.na/books/about/The_Economic_Geology_of_the_Country_Arou.html?id=s2RRAQAAIAAJ&redir_esc=y

Economist Intelligence Unit (EIU, 2023), Things to Watch in Africa, Things to watch in Africa in 2023 accessed at https://country.eiu.com/article.aspx?articleid=1952522378&Country=Nigeria&topic=Economy&subtopic=Outlook&subsubtopic=Overview

Financial Gazette, US$4bln Target for Foreign Direct Investment is Achievable, Thursday, 6 July 2023,

Fraser Institute (2022). Annual Survey of Mining Companies, 2022. https://www.fraserinstitute.org/sites/default/files/annual-survey-of-mining-companies-2022.pdf

Government of Zimbabwe (2018), VISION 2030 "Towards a Prosperous & Empowered Upper Middle Income Society by 2030" Government of Zimbabwe Documents and Forms.

Government of Zimbabwe (2023) Zimbabwe Public Debt Report, https://parlzim.gov.zw/public-debt-report-zimtreasury-zpdmo/

Funded by
the European Union

Government of Zimbabwe (2023), 2024 National Budget Statement. The 2024 Budget Statement.pdf (veritaszim.net)

Government of Zimbabwe (2020), National Economic Development Strategy 1, "Towards a Prosperous & Empowered Upper Middle-Income Society by 2030", National Development Strategy Document Final web (un.org).

Government of Zimbabwe (2007), Indigenization and Economic Empowerment Act [Chapter 14:33] of 2007.

Gunn G & Benham A. (2009) Platinum. British Geological Survey. Natura Environment Research Council.

The Indigenization and Economic Empowerment Act [Chapter 14:33] of 2007 accessed at CHAPTER 14:33 (jsc.org.zw) on 12december 2023

International Energy Agency (2022), The Role of Critical Minerals in Clean Energy Transition: World Outlook Special Report, The Role of Critical Minerals in Clean Energy Transitions (windows.net)

International Institute for Sustainable Development (IISD, 2018), Six Key Factors in Formalizing the Artisanal and Small-Scale Mining, Six Key Factors in Formalizing Artisanal and Small-Scale Mining | International Institute for Sustainable Development (iisd.org)

International Tungsten Industry Association. (2005). Tungsten Uses http://www.itia.info. Default.asp?page=25

Jelsma H.A., Nesbitt R.W., Fanning C.M. (2021). Exploring our current understanding of the geological evolution and mineral endowment of the Zimbabwe Craton. South African Journal of Geology. Volume 124.1. Page 279-310.

Johan, Z., Ohnenstetter, D., and Naldrett, A.J., 1989, Platinum-group minerals and associated oxides and base metal sulfides of the Main sulphide zone, Great Dyke, Zimbabwe: Bulletin of the Geological Society of Finland, v. 61, p. 53–54.

Kaufmann D., Kraay A., Mastruzzi M., 2010. The Worldwide Governance Indicators: Methodology and Analytical Issues. World Bank Policy Research Working Paper 5430.

Kaufmann D and Kraay A. (2023). Worldwide Governance Indicators, 2023 Update (www.govindicators.org), Accessed on 10/19/2023.

LaRocca G.M. (2020) Global Value Chains: Lithium in Lithium-ion Batteries for Electric Vehicles. Available at: https://www.usitc.gov/publications/332/working_papers/no_id_069_gvc_lithium-ion_batteries_electric_vehicles_final_compliant.pdf

Leuenberger, A. (2021). Investigating health impacts and equity in communities surrounding large natural resource extraction projects in sub-Saharan Africa: a contribution to sustainable development (Doctoral dissertation, University_of_Basel_Associated_Institution).

LPI 2023 a) https://lpi.worldbank.org/international/global

Funded by
the European Union

LPI 2023 b) 2023/C/ZAF/2023/C/ZMB/2023/C/MWI/2023/C/BWA/2023

LPI 2023 c) https://data.worldbank.org/indicator/LP.LPI.OVRL.XQ?locations=ZW

Mabhiza L. (2006) An overview of PGM Smelting in Zimbabwe –Zimplats Operations, Zimplats, Selous, Zimbabwe. Southern African Pyrometallurgy 2006, Edited by R.T. Jones, South African Institute of Mining and Metallurgy, Johannesburg, 5-8 March 2006

Markwitz, V., Maier, W. D., Gonzalez-Alvarez, I., McCuaig, T. C., & Porwal, A. (2010). Magmatic nickel sulfide mineralization in Zimbabwe: Review of deposits and development of exploration criteria for prospectivity analysis. Ore Geology Reviews, 38(3), 139-155.

Mamina M T. (2019) Nickel: Demand trends and Opportunities for Zimbabwean Miners accessed at (3) Nickel: Demand trends and Opportunities for Zimbabwean Miners | LinkedIn

Maponga, O., & Meck, M. (2003). Illegal artisanal gold panning in Zimbabwe: A study of challenges to sustainability along Mazowe River. The socio-economic impact of small scale mining in developing countries. The Netherlands: AA Balkema.

Masimirembwa, M. T., & Harawa, M. S. (2019). Petrology and geochemistry of pegmatites and associated rocks from the Domboshawa area, Zimbabwe. Journal of African Earth Sciences, 150, 1-151

Master, S., Bekker, A., & Hofmann, A. (2010) A review of the stratigraphy and geological setting of the Palae-oproterozoic Magondi Supergroup, Zimbabwe – Type locality for the Lomagundi carbon isotope excursion. Precambrian Research 182, 254–273

Metals of Africa Limited (2012) Joint Venture Agreement-Changara Project. Available at: https://announcements.asx.com.au/asxpdf/20121128/pdf/42bjkcnl3nmdzx.pdf

Michaels, K.C., Maréchal, L. and Katz, B., 2022. Why is ESG so important to critical mineral supplies, and what can we do about it?

Mimosa (2023) Mineral Resources and Mineral Resources. Available at: https://www.mimosa.co.zw/operations/mineral-resources-and-mineral-reserves

Mines and Minerals Act 1961 available at CHAPTER 21:05 (jsc.org.zw)

Mining Technology (2014) RHA Tungsten Project. Available at:https://www.mining-technology.com/projects/rha-tungsten-project/#:~:text=of%20Bulawayo%2C%20Zimbabwe.-,The%20RHA%20tungsten%20project%2C%20developed%20by%20Premier%20Africa%20Minerals%2C%20is,CaWO4)%20are%20also%20present.

Mining Zimbabwe, A Closer Look at Mining Investment Opportunities Available in Zimbabwe, April 19, 2023, Issue 65, A closer look at mining investment opportunities available in Zimbabwe - Mining Zimbabwe.

Mudimbu, D., Meck, M.L.2018 Spatial Relationships between Contaminated Mining areas and Pathological States around Kadoma, Zimbabwe. In De Souza, K and Mogessie, "Geology and Mineral Information System (GMIS) Strategy to Domesticate the Africa Mining Vision at a Country Level"

Funded by
the European Union

African Minerals Development Centre – AMDC United Nations Economic Commission for Africa – UNECA, Addis Ababa, Ethiopia,

Oberthür T, Melcher F, Buchholz P, and M. Locmelis M. (2002) The oxidized ores of the Main Sulphide Zone, Great Dyke, Zimbabwe: Turning resources into mineral reserves- Mineralogy is the key

Prendergast, M. 2016. Nickel laterite deposits of the northern part of the Great Dyke. Macgregor Memorial Lecture, 68pp. http://www.geologicalsociety.org.zw/sites/default/files/news-attachments/Macgregor%20Memorial%20Lecture%202016%2020%20Prendergast%20on%20Great%20Dyke%20Ni%20Laterites-web.pdf.

RBZ (2022) Increased Gold Delivery to Fidelity Refinery (Private) Limited in 2021: *Press Statement. Available at:* https://www.rbz.co.zw/documents/press/2022/January/FGR-Appreciation-for-Gold-Deliveries.pdf

Rouget. V (2023), Political Risks in Africa's Top Mining Markets, Control Risks, Political risk issues to watch in Africa's top 8 mining markets (controlrisks.com);

Singo, J., Moyo, D., Isunju, J. B., Bose-O'Reilly, S., Steckling-Muschack, N., Becker, J., & Mamuse, A. (2022). Health and safety risk mitigation among artisanal and small-scale gold miners in Zimbabwe. International journal of environmental research and public health, 19(21), 14352.

Spiegel, S. J., & Mwita, A. (2018). Shifting formalization policies and recentralizing power: The case of Zimbabwe's artisanal gold mining sector. Society & Natural Resources, 31(5), 556-571.

SRK Consulting (2007) An Independent Technical Report on Bindura Nickel Corporation, Freda Rebecca Mine and Semkhat (Anmerosa Exploration Congo SPRL), The material assets of Mwana Africa PLC.

Tae-Yoon Kim (2022), Critical minerals threaten a decades-long trend of cost declines for clean energy technologies, Critical minerals threaten a decades-long trend of cost declines for clean energy technologies – Analysis - IEA.

The Herald, President Commissions another Signature Project, Thursday, 6 July 2023, President commissions another signature project | The Sunday News.

The Royal Mint (2023), Is Platinum a Good Investment? Is Platinum a Good Investment? | The Royal Mint.

UNCCD (2023) https://www.unccd.int/resources/knowledge-sharing-system/soil-and-terrain-digital-database-soter

Vella, A. 2023. Highlighting mineralized geological environments through a new Data-driven predictive mapping approach. PhD thesis University Orléans, France https://www2.gnb.ca/content/dam/gnb/Departments/en/pdf/Minerals-Minerales/MCP_7-e.pdf

Vines. A. (2023), Africa in 2023: Continuing political and economic volatility, Chatham House, Africa in 2023: Continuing political and economic volatility | Chatham House – International Affairs Think Tank.

Funded by
the European Union

Wilson A H and Prendergast M. (2001) Platinum-Group Element Mineralisation in the Great Dyke, Zimbabwe, and its Relationship to Magma Evolution and Magma Chamber Structure. South African Journal of Geology (2001) 104 (4): 319–342. https://doi.org/10.2113/gssajg.104.4.319

Wilson, A.H. & Tredoux, M. (1990). Lateral and vertical distribution of the platinum-group elements and petrographic controls on the sulfide mineralization in the Pl pyroxenite layer of the Darwendale subchamber of the Great Dyke, Zimbabwe. Econ. Geol., 85,

WPIC_Platinum_Essentials_December_2022 (Updated Supply Demand outlook from 2024-2026 as well as initial estimates for 2027) (platinuminvestment.com) Wood, A, Dan, & Hedenquist, J. (2019).

World Bank (2020), Minerals for Climate Action: The Mineral Intensity of Clean Energy Transition, Minerals for Climate Action - The Intensity of the Clean Energy Transition (mineral-choices.com)

World Platinum Investment Council (2022), 60 Seconds in Platinum: Critical Mineral, Critical mineral (royalmint.com)

World Platinum Investment Council (2022), Platinum Essentials Updating WPIC's two- to five-year supply/demand outlook: Sustained platinum deficits, WPIC_Platinum_Essentials_December_2022 (Updated Supply Demand outlook from 2024-2026 as well as initial estimates for 2027) (platinuminvestment.com)

World Platinum Investment Council (2023), Platinum recycling and the circular economy, Platinum recycling and the circular economy - CME Group

ZEPARU. (2020). Improving Service Delivery by Local Authorities in Zimbabwe: Challenges and Opportunities. Harare: ZEPARU. Retrieved from https://www.zeparu.co.zw/sites/default/files/publications/2020-12/Improving%20Service%20Delivery%20by%20Local%20Authorities%20in%20Zimbabwe.pdf

Zimbabwe Economic Policy Analysis and Research UNIT
https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://zepari.co.zw/sites/default/files/2018-03/Policy%2520Brief%2520in%2520depth%2520training%2520needs%2520assessment%2520survey%2520policy%2520brief%2520new.pdf&ved=2ahUKEwi46ZnKiIeEAxXJXUEAHbMuAy8QFnoECBEQAQ&usg=AOvVaw0PZzER8wMpRsVmvTGXa9rA

Zimplats (2022). Creating a Better Future. 2022 Integrated Annual Report.

Zimplats (2021) Creating a Better Future. 2021 Integrated Annual Report

Zimunya, T., & Dube, E. (2019). Artisanal and small-scale mining as a challenge and possible contributor to sustainable development in Zimbabwe: A case study of Shurugwi district. Journal of Sustainable Development in Africa, 21(2), 1-15.

Funded by
the European Union

APPENDICES

Funded by
the European Union

Country: ZIMBABWE

MINERAL POTENTIAL MAP - *BERYLLIUM (Be)*

Africa MaVal

28°0'E 32°0'E 14°0'S 18°0'S 22°0'S

Ndola
Lusaka
ZAMBIA
MOZAMBIQUE
Harare
Marondera
Mutare
Gweru
Masvingo
Bulawayo
Francistown
BOTSWANA
Musina
Louis Trichardt
SOUTH AFRICA
Polokwane
Mokopane
Gaborone

Mineral Potential Map

Structures

Thrust — Fault

References:
SIG Afrique at 1/2 000 000 scale - © BRGM 2018

ZAMBIA
MOZAMBIQUE
BOTSWANA
SOUTH AFRICA

Geological Map

Legend

Score

- < 0.05
- 0.05 - 0.125
- 0.125 - 0.25
- 0.25 - 0.45
- 0.45 - 0.60
- 0.60 - 0.80
- 0.80 - 1

Known occurrences

Beryllium (Be)
SIG Afrique - © BRGM 2018

Confusion matrix

True negative Cells: 72099 92.17% Non-occurrence in database Non-occurrence predicted	False positive Cells: 5735 7.33% Non-occurrence in database Occurrence predicted
False negative Cells: 18 0.02% Occurrence in database Non-occurrence predicted	True positive Cells: 374 0.48% Occurrence in database Occurrence predicted

Best threshold (G-Means): 0.50
Cell size: 2250 m

0 50 100 200 Km

Datum : WGS84 (World Geodetic System 1984)

January 2024

brgm Géosciences pour une Terre durable

Country: ZIMBABWE

MINERAL POTENTIAL MAP - *LITHIUM (Li)*

Africa MaVal

28°0'E 32°0'E 14°0'S 18°0'S 22°0'S

Ndola
Lusaka
ZAMBIA
MOZAMBIQUE
Harare
Marondera
Mutare
Gweru
Masvingo
Bulawayo
Francistown
BOTSWANA
Musina
Louis Trichardt
SOUTH AFRICA
Polokwane
Mokopane
Gaborone

Mineral Potential Map

Structures

Thrust — Fault

References:
SIG Afrique at 1/2 000 000 scale - © BRGM 2018

ZAMBIA
MOZAMBIQUE
BOTSWANA
SOUTH AFRICA

Geological Map

Legend

Score

- < 0.05
- 0.05 - 0.125
- 0.125 - 0.25
- 0.25 - 0.45
- 0.45 - 0.60
- 0.60 - 0.80
- 0.80 - 1

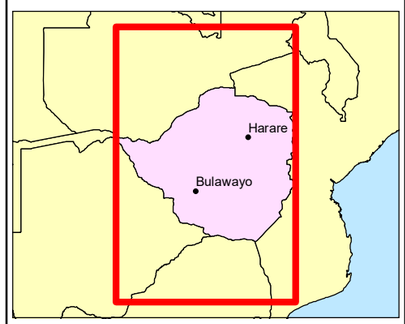
Known occurrences

Lithium (Li)
SIG Afrique - © BRGM 2018

Confusion matrix

True negative Cells: 74000 94.60% Non-occurrence in database Non-occurrence predicted	False positive Cells: 4135 5.29% Non-occurrence in database Occurrence predicted
False negative Cells: 2 0.00% Occurrence in database Non-occurrence predicted	True positive Cells: 89 0.11% Occurrence in database Occurrence predicted

Best threshold (G-Means): 0.52
Cell size: 2250 m



N

0 50 100 200 Km

Datum : WGS84 (World Geodetic System 1984)

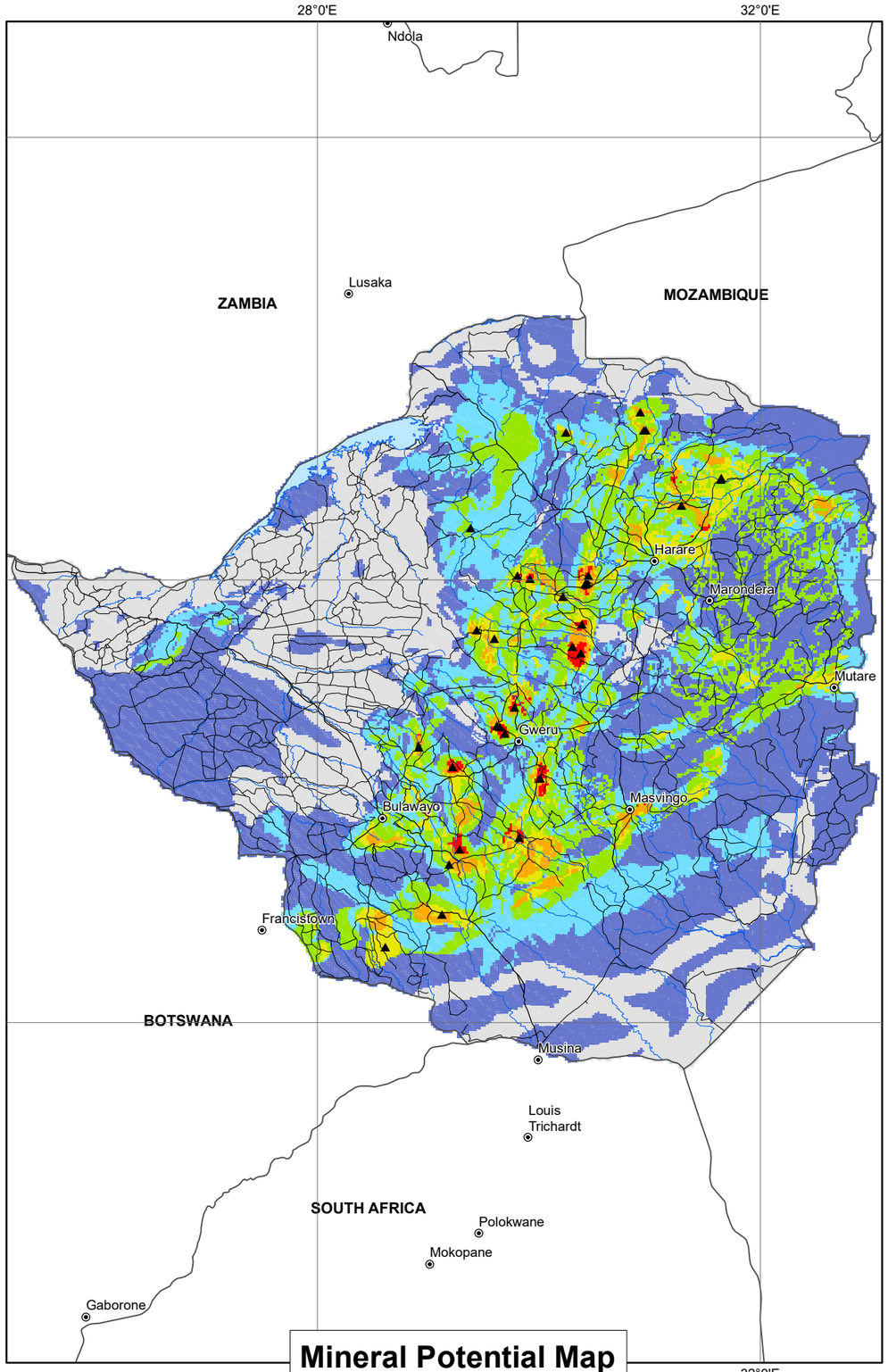
January 2024

Géosciences pour une Terre durable
brgm

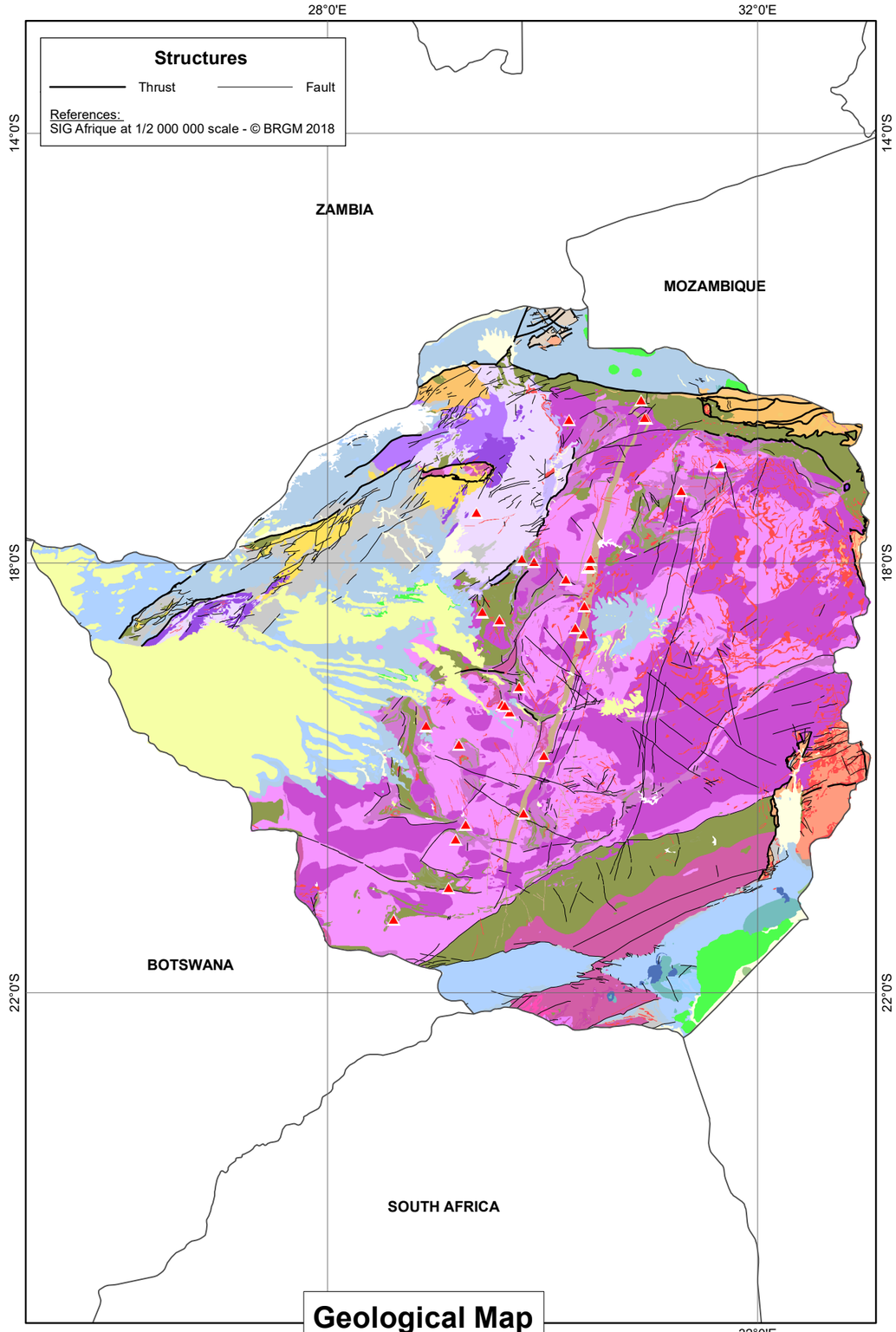
Country: ZIMBABWE

MINERAL POTENTIAL MAP - *NICKEL (Ni)*

Africa MaVal



Mineral Potential Map



Geological Map

Legend

Score

- < 0.05
- 0.05 - 0.125
- 0.125 - 0.25
- 0.25 - 0.45
- 0.45 - 0.60
- 0.60 - 0.80
- 0.80 - 1

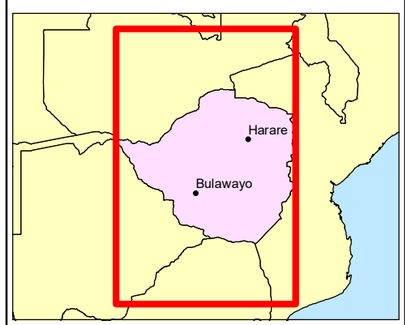
Known occurrences

Nickel (Ni)
SIG Afrique - © BRGM 2018

Confusion matrix

True negative Cells: 74763 95.57% Non-occurrence in database Non-occurrence predicted	False positive Cells: 3384 4.33% Non-occurrence in database Occurrence predicted
False negative Cells: 5 0.01% Occurrence in database Non-occurrence predicted	True positive Cells: 74 0.09% Occurrence in database Occurrence predicted

Best threshold (G-Means): 0.50
Cell size: 2250 m



N

0 50 100 200 Km

Datum : WGS84 (World Geodetic System 1984)

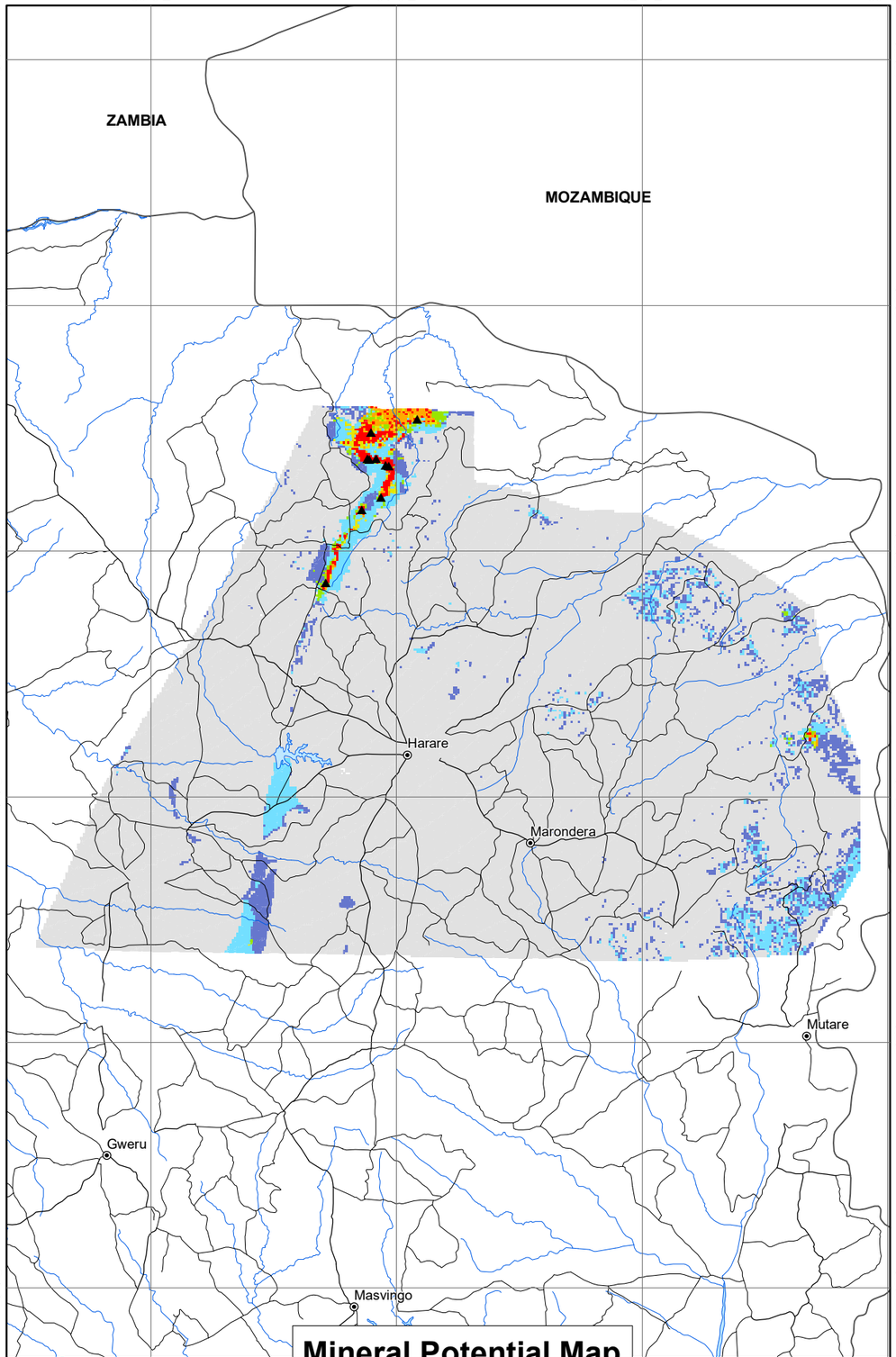
January 2024

Géosciences pour une Terre durable
brgm

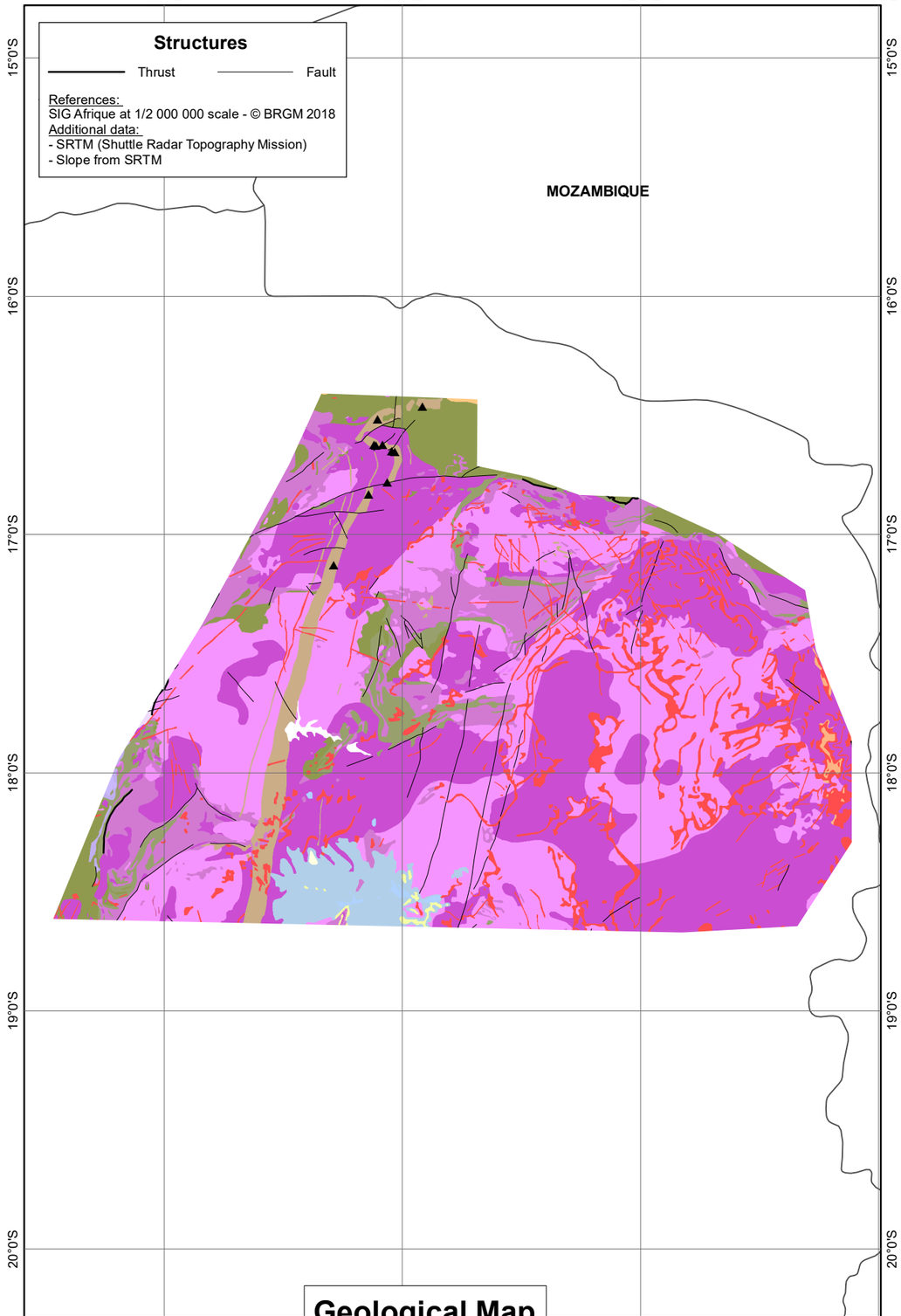
Country: ZIMBABWE (North East)

MINERAL POTENTIAL MAP - *LATERITIC NICKEL (Ni)*

Africa MaVal



Mineral Potential Map



Geological Map

Legend

Score

- < 0.05
- 0.05 - 0.125
- 0.125 - 0.25
- 0.25 - 0.45
- 0.45 - 0.60
- 0.60 - 0.80
- 0.80 - 1

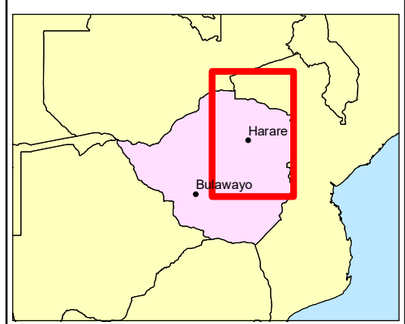
Known occurrences

▲ ▲ Lateritic nickel (Ni)
McGregor - 2016

Confusion matrix

True negative Cells: 62240 99.41% Non-occurrence in database Non-occurrence predicted	False positive Cells: 344 0.55% Non-occurrence in database Occurrence predicted
False negative Cells: 0 0.00% Occurrence in database Non-occurrence predicted	True positive Cells: 28 0.04% Occurrence in database Occurrence predicted

Best threshold (G-Means): 0.68
Cell size: 1000 m



N

0 25 50 100 Km

Datum : WGS84 (World Geodetic System 1984)

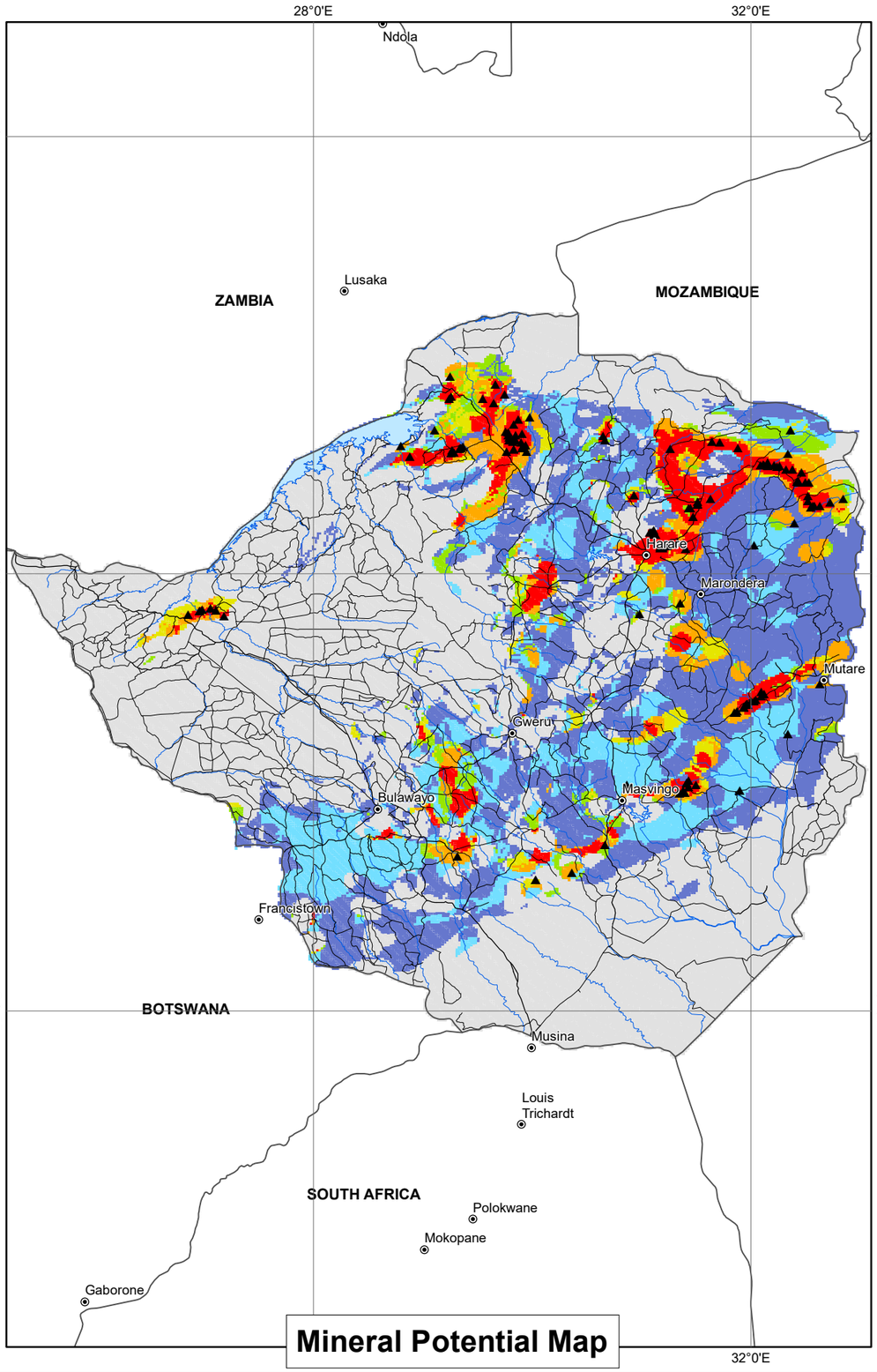
January 2024

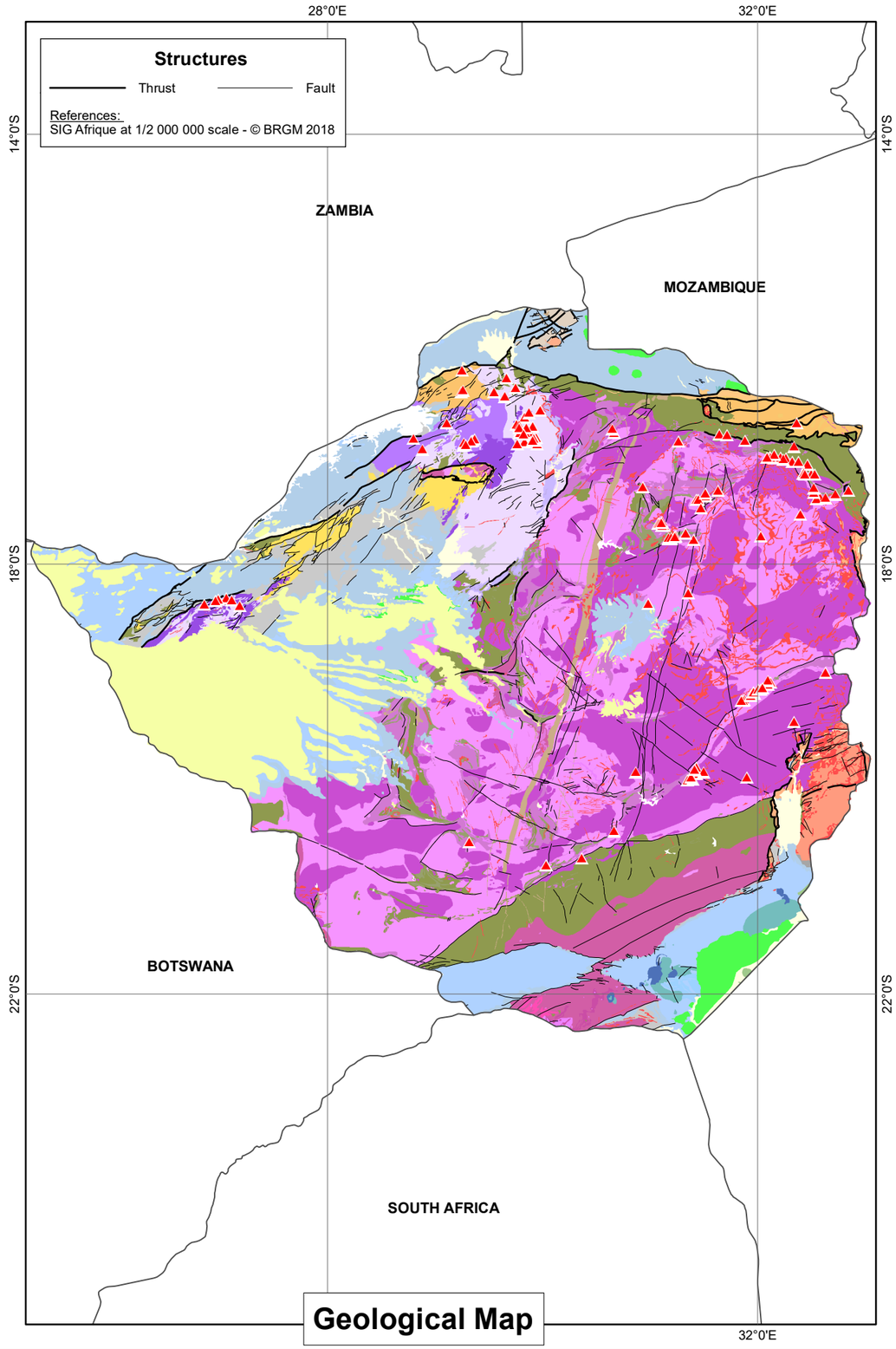
Géosciences pour une Terre durable
brgm

Country: ZIMBABWE

MINERAL POTENTIAL MAP - *TANTALUM (Ta)*

Africa MaVal





Legend

Score

- < 0.05
- 0.05 - 0.125
- 0.125 - 0.25
- 0.25 - 0.45
- 0.45 - 0.60
- 0.60 - 0.80
- 0.80 - 1

Known occurrences

Tantalum (Ta)
SIG Afrique - © BRGM 2018

Confusion matrix

True negative Cells: 70780 90.48% Non-occurrence in database Non-occurrence predicted	False positive Cells: 7171 9.17% Non-occurrence in database Occurrence predicted
False negative Cells: 16 0.02% Occurrence in database Non-occurrence predicted	True positive Cells: 259 0.33% Occurrence in database Occurrence predicted

Best threshold (G-Means): 0.52
Cell size: 2250 m

0 50 100 200 Km

Datum : WGS84 (World Geodetic System 1984)

January 2024

brgm Géosciences pour une Terre durable

Country: ZIMBABWE

MINERAL POTENTIAL MAP - *TUNGSTEN (W)*

Africa MaVal

28°0'E 32°0'E 14°0'S 18°0'S 22°0'S

Ndola
Lusaka
ZAMBIA
MOZAMBIQUE
Harare
Marondera
Mutare
Gweru
Masvingo
Bulawayo
Francistown
BOTSWANA
Musina
Louis Trichardt
SOUTH AFRICA
Polokwane
Mokopane
Gaborone

Mineral Potential Map

Structures

Thrust — Fault

References:
SIG Afrique at 1/2 000 000 scale - © BRGM 2018

ZAMBIA
MOZAMBIQUE
BOTSWANA
SOUTH AFRICA

Geological Map

Legend

Score

- < 0.05
- 0.05 - 0.125
- 0.125 - 0.25
- 0.25 - 0.45
- 0.45 - 0.60
- 0.60 - 0.80
- 0.80 - 1

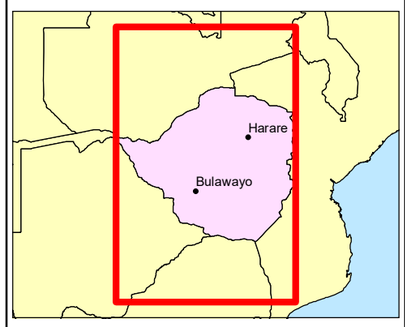
Known occurrences

▲ ▲ Tungsten (W)
SIG Afrique - © BRGM 2018

Confusion matrix

True negative Cells: 69479 88.81% Non-occurrence in database Non-occurrence predicted	False positive Cells: 8187 10.47% Non-occurrence in database Occurrence predicted
False negative Cells: 14 0.02% Occurrence in database Non-occurrence predicted	True positive Cells: 546 0.70% Occurrence in database Occurrence predicted

Best threshold (G-Means): 0.50
Cell size: 2250 m



N

0 50 100 200 Km

Datum : WGS84 (World Geodetic System 1984)

January 2024

Géosciences pour une Terre durable
brgm