HIGH-LEVEL BASELINE STUDY

PRIVATE MINING SECTOR IN NAMIBIA

by

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DRFN

Enhancing decision making for sustainable development

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Abstract

Mining has been the backbone of the Namibian economy for more than a century, and commodities produced include copper, diamonds, gold, iron, lead, tin, uranium, and zinc, which are recovered from a variety of metallogenic provinces.

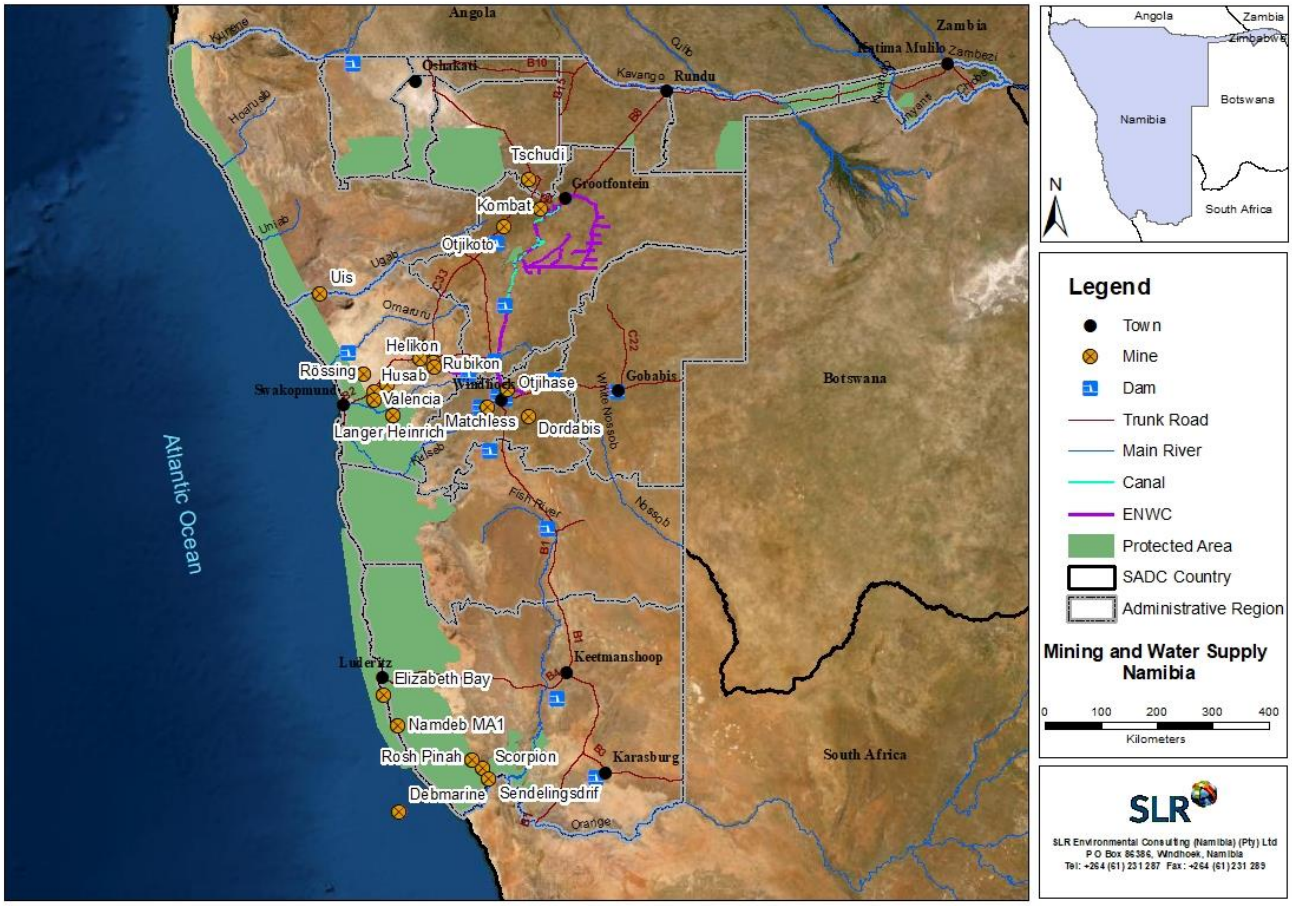
Diamonds are Namibia's most valuable commodity, contributing 2.6% to GDP, and 15.4% to all exports in 2021. Diamonds have been mined in Namibia since 1908, and the country hosts the World's largest diamond placer. In 2021, Namibia was also the 2nd largest producer of uranium in the World. Namibia's uranium activities are concentrated in the central western part of the country, where Late Neoproterozoic leucogranites carry minable amounts of uranium, and are also the source rocks for uranium deposits in younger sediments.

Copper has been mined in the Otavi Mountainland in the north of the country since the turn of the last century, most prominently in the famous Tsumeb Mine. However, there has also been intermittent production in the central part of the country, and zinc is produced in the far south. Namibia also has two gold mines, and a third one is in the process of being opened up. A variety of pegmatite deposits supports tin and lithium mining, mainly in the central part of Namibia. While not a traditional iron producer, the country also has a smaller iron ore mine since 2015.

1. General overview mining in Namibia

The earliest mining activities in Namibia date back some 400 years according to archaeological evidence of copper smelting in the area west of Windhoek. Namibia's oldest formal mine, the Matchless Mine, opened in 1856. Many famous discoveries would follow, including the Tsumeb Mine, which started production in 1906, and the discovery of the World's largest diamond placer in 1908. Since then mining has developed into the backbone of the Namibian economy, contributing more than 9% to GDP, and almost 55% of all exports. Mining is an important employer, and contributes substantially in the form of taxes, royalties and local procurement.

The diversity of Namibia's mines reflects the wide variety of metallogenic provinces. Commodities produced include copper, diamonds, gold, iron, lead, tin, uranium, and zinc. A geographical overview is given in the following figure.



2. Mining activity by commodity

2.1 Uranium

Almost all of Namibia's uranium activities are concentrated in the central western part of the country, also referred to as the Namibian Uranium Province. Here, Late Neoproterozoic leucogranites, termed alaskites carry minable amounts of uranium, and are also the source rocks for uranium deposits in young pedogenic and sedimentary sequences.

In 2021, Namibia was the 2nd largest producer of uranium in the World.

2.1.1 Rössing

- The Rössing Uranium Mine, some 60 km northeast of Swakopmund, is the World's largest open pit uranium mine, and with 46 years of operation the longest active uranium mine in the World. It is operated by majority shareholder CNNC.
- The primary ore comprises of uraniferous alaskites.
- The ore is mined from an open pit by conventional means using drilling, blasting, loading and hauling equipment.
- The ore is processed by leaching with sulphuric acid, slime separation in cyclones, counter-current decantation, continuous ion-exchange, solvent extraction, precipitation, filtration, and final drying and roasting.
- In 2021, Rössing produced 2882 t of uranium oxide.

2.1.2 Swakop Uranium

- Swakop Uranium's Husab Mine, in the Namib Naukluft National Park directly southwest of Rössing, is also one of the largest uranium mines in the World.
- Husab is operated by majority shareholder CGNPC.
- Its first production was in 2016, and since then the mine is ramping up to reach name plate production.
- The primary ore comprises of uraniferous alaskites.
- The ore is mined from an open pit by conventional means using drilling, blasting, loading and hauling equipment.
- The beneficiation process starts with crushing, followed by milling, leaching with sulphuric acid, counter-current decantation, ion exchange, solvent extraction, and final recovery by drying and roasting.
- In 2021, Swakop Uranium produced 3902 t of uranium oxide.

2.1.3 Langer Heinrich

- The Langer Heinrich Mine lies some 80 km east of Walvis Bay in the Namib Naukluft National Park. It first produced in 2007, but was placed on care and maintenance in 2018 due to the low uranium price.
- It is operated by majority shareholder Paladin Resources.
- A decision to restart the mine was taken in July 2022, and full production is anticipated for Q1 2024.
- The secondary ore comprises of uraniferous calcrete.
- The ore was mined from an open pit by conventional means using drilling, blasting, loading and hauling equipment.
- The ore was processed using conventional methods of crushing, scrubbing, separation using cyclones and screens, alkaline leaching, counter-current decantation, ion exchange, precipitation and calcining.
- Between 2007 and 2018, the Langer Heinrich Mine produced some 16 500 t of uranium oxide.

2.1.4 Trekkopje

- The Trekkopje Mine is situated 70 km northeast of Swakopmund, and operated by Orano.
- Since 2008, it was developed in three phases, as its ore body presents a technical challenge due to its low uranium content.
- Unfortunately, it had to be placed on care and maintenance in 2013 due to the low uranium price.
- The secondary ore comprises of uraniferous calcrete.
- The ore was mined from an open pit by conventional means using drilling, blasting, loading and hauling equipment.
- The ore was crushed by portable primary crushers near the pit and transported by conveyors to heap leach pads, where it was subjected to alkaline leaching, followed by ion exchange, solvent extraction, precipitation, filtration and drying.
- From 2012 to 2013, the Trekkopje Mine produced 437 t of uranium oxide.

2.1.5 Zhonghe Resources

- Zhonghe Resources is an exploration company with a mining license and a number of exploration licenses to the northeast of Rössing.
- Mineralisation is both, primary and secondary.

- The projects are in the exploration stage and no production has occurred yet.

2.1.6 Valencia

- Valencia is a uranium deposit located on the eastern edge of the Khan Valley some 80 km from Swakopmund.
- The primary ore comprises of alaskites.
- Valencia uranium has a definitive feasibility study and mining license in place, and is therefore construction-ready once the uranium price has reached the required level.
- The preferred mining method is a traditional open pit operation employing excavators, haul trucks and bench drills.
- The anticipated processing method is acid leaching.

2.1.7 Bannerman

- Bannerman Resources owns the advanced Etango exploration project 30 km southeast of Swakopmund.
- The primary ore comprises of alaskites.
- A Heap Leach Demonstration Plant was put in place in 2015 to establish the preferred leaching process method.
- The Definitive Feasibility Study for the establishment of an open cast mine is expected to be completed in September 2022.

2.1.8 Reptile Uranium

- Reptile Mineral Resources and Exploration is an advanced stage uranium exploration company with large tenements in the northwestern part of the Namib Naukluft National Park.
- Mineralisation is both, primary and secondary.
- Uranium mineralisation at the Tumas Project is hosted by calcretised palaeochannel sediments, very similar to Langer Heinrich, located some 27 kilometres northeast of that mine.
- The Definitive Feasibility Study for Tumas is expected to be completed in the latter half of 2022, and a Mining Licence has been applied for.

2.1.9 Elevate Uranium

- Elevate Uranium is the largest uranium tenement holder in Namibia and operates in the northwestern Namib Naukluft National Park. It also holds the Marenica project to the northeast of Trekkopje Mine under a Mineral Deposit Retention License.
- Its targets are secondary mineralised palaeo-channels.
- Active exploration is ongoing.
- Elevate Uranium owns the patented U-pgrade™ process that rejects greater than 95% of the mass of uranium ore by utilising commonly used beneficiation processes, which enable the removal of the non-uranium bearing minerals.

2.2 Copper

2.2.1 Tsumeb

- The Tsumeb Mine is situated in the town of Tsumeb in northern central Namibia.

- The Tsumeb ore body is a hydrothermal polymetallic pipe-like deposit in predominantly dolomitic successions of the Otavi Group.
- It was in operation from 1907 to 1991, but closed down just before the ore reserves were exhausted.
- Underground mining was by cut-and-fill method.
- Ore beneficiation took place in a classic flotation plant, however, to get better recovery of the oxide minerals of this multi-phase mineralisation, a gravity plant was added in 1987.
- The first smelter was erected at Tsumeb as early as 1907, and was the precursor of the current Tsumeb Smelter.

2.2.2 Tschudi

- Tschudi Copper Mine is located west of Tsumeb in the Otavi Mountainland (Oshikoto Region) and is owned by Weatherly International PLC.
- The disseminated copper-pyrite mineralisation is hosted by arenites of the Mulden Group.
- The operation is a conventional open pit.
- Ore was processed by heap leaching followed by electro-wining.
- The mine is currently under care and maintenance.

2.2.3 Kombat

- The Kombat Mine is located in the Otavi Valley some 37 km east of Otavi, and operated by Trigon Mining.
- Kombat Mine is the only mine in Namibia that has been developed in the early 20th century, in 1911, and which is still operating, albeit intermittently.
- There is currently only a small open cast mine, and operations have once more been suspended as from 01/08/2022 because of the low copper price.
- However for most of its productive life, the mine was an underground operation.
- The Kombat ore bodies are located in the contact zone between phyllite of the Kombat Formation and the underlying dolomites of the Tsumeb Subgroup.
- The various ore types include massive and semi-massive sulphides, vein-fracture systems, alteration breccias, mineralised fracture fillings, as well as some iron and manganese. They are of epigenetic, hydrothermal and metasomatic replacement origin.

2.2.4 Otjihase

- The Otjihase underground mine is located some 40km northeast of Windhoek and has been in operation intermittently since Independence.
- The mine first opened in 1975.
- The Otjihase Mine is currently under Care and Maintenance.
- The Otjihase mineralisation is closely associated with magnetite quartzite of the Matchless Amphibolite Belt, A MORB-type feature forming discontinuous layers in the schists of the Kuiseb Formation.
- The mineralisation is of the Volcanogenic Massive Sulphide type.
- Ore is mined by pillar-and-bay stoping.

- The plant is a conventional floatation operation.

2.2.5 Matchless

- The Matchless Mine is situated in the Khomas Hochland to the west of Windhoek.
- It is Namibia's oldest formal mine, and opened first in 1840.
- Currently, the mine is under Care and Maintenance.
- The Matchless mineralisation is closely associated with magnetite quartzite of the Matchless Amphibolite Belt, A MORB-type feature forming discontinuous layers in the schists of the Kuiseb Formation.
- The mineralisation is of the Volcanogenic Massive Sulphide type.
- Ore was mined by cut-and-fill stoping methods.
- The plant is a conventional floatation operation.

2.3 Lead-Zinc

2.3.1 Rosh Pinah

- The Rosh Pinah mine is situated in the Karas Region, 165 km south of Aus, approximately 23 km north of the Orange River.
- The mine is situated on state-owned land which borders with privately owned farms.
- The Rosh Pinah mine is 90% owned by Trevali Mining Cooperation and 10% by Namibian Broad-Based Empowerment Groupings and an Employee Empowerment Participation Scheme (EEPS).
- The mining licence No. 39 (ML 39) is held by PE Minerals. PE Minerals and RPZC have an Operational Agreement in which PE Minerals transferred all mining interest to RPZC. The Operational Agreement has been approved in writing by MME in 1999.
- The Rosh Pinah mine has been in continuous operation since 1969 and currently produces zinc and lead sulphide concentrates containing minor amounts of copper, silver, and gold.
- The Rosh Pinah Mine is hosted by the Rosh Pinah Formation (Hilda Subgroup of the Port Nolloth Group), forming part of the Neoproterozoic Gariep Terrane deposited onto a Palaeo-Mesoproterozoic basement of granite gneisses and supracrustals.
- The base metal sulphides at the Rosh Pinah mine are contained within the approximately 30-metre thick ore equivalent horizon (OEH). In the Rosh Pinah area, the Rosh Pinah Formation has been shown to be at least 1,250 metres thick.
- It is believed to represent a classic reworked sedimentary-exhalative (SEDEX) style exhalate deposit.
- The mining method includes: 2,000 tonne per day processing mill, flotation recovery plant, metallurgical and geochemical laboratories and a tailings facility.
- In 2021 RPZC produced 83,362 tonnes of zinc and 19,989 tonnes of lead.

2.3.2 Skorpion

- Skorpion Zinc Mine is located some 20km northwest of Rosh Pinah.

- The project is currently under Care and Maintenance due to geothechnical instabilities present in the pit, but there are plans to re-open the mine soon.
- The mine and associated Namzinc Refinery used to produce Special High Grade Zinc (SHG Zinc) from its open pit mine for export to the world markets.
- Skorpion Zinc is currently assessing options to safely mine the remaining ore and the conversion of its refinery to process primary zinc sulphides.

2.4 Gold

2.4.1 Navachab

- Navachab Gold Mine is located approximately 10km southwest of Karibib in Central Namibia.
- The Navachab Gold Mine is owned by QKR Namibia (Pty) Ltd.
- The mine is run as an open pit operation.
- Navachab has been operating since early 1990 and uses CIP (carbon-in-pulp) technology to produce doré bullion that is subsequently shipped off-site for refinement.
- The Navachab Mine produced 1 502 kg gold bullion in 2021.

2.4.2 Otjiikoto

- The mine is situated between Otjiwarongo and Outjo in north-central Namibia.
- The Otjikoto Mine is owned by B2Gold Namibia (Pty) Ltd.
- B2Gold acquired the Company's first African gold development project, the Otjikoto Gold Project, through a merger with Auryx Gold Corp. in December 2011. The Company received the Otjikoto Mining Licence in December 2012, and construction of the Otjikoto Mine commenced in April 2013. Within approximately 19 months, the first gold pour occurred on December 11, 2014, ahead of schedule. Underground mining started in 2022.
- The mine operates an open pit, and since the beginning of 2022 also some underground workings.
- In 2021, the Otjikoto Mine produced 4 763 kg of gold bullion.
- The Otjikoto Mine is expected to produce between 175,000 - 185,000 ounces of gold in 2022.

2.4.3 Twin Hills

- The Twin Hills project is owned by Osino Resources.
- The site is located approx. 12 km North of Karibib next to the C33 to Omaruru.
- Twin Hills was discovered in 2019.
- On 12 April 2021, the company released its maiden mineral resource estimate comprising 13.5 million t at an average grade of 1 g/t gold.
- The Twin Hills mine development is in progress.

2.5 Diamonds

Diamonds are Namibia's most valuable commodity, contributing 2.6% to GDP, and 15.4% to all exports in 2021. Diamonds have been mined in Namibia since 1908, and the country hosts the

World's largest diamond placer. 95% of the stones are of best gem stone quality, and Namibia is the World's leading marine diamond producer. Most operations belong to Namdeb Holdings, a joint venture between the Namibian government and the DeBeers Group, while the Elizabeth Bay mine, previously also a Namdeb mine, was recently sold to Sperrgebiet Diamonds.

2.5.1 Namdeb MA1

- Namdeb's Mining Area 1 in the southern coastal area reaches from the mouth of the Orange River near Oranjemund to north of Chameis Bay, a distance of about 100 km. The license extends from about 5.5 km offshore to about 35 km inland.
- The diamonds are mined from the gravels of marine raised beaches.
- The ore is recovered in small open cast operations utilising advanced sea wall mining techniques, overburden removal, excavating, and manual gravel recovery using transvac machines.
- The gravel is then transported to central recovery plants employing crushing if required, screening, dense medium separation, X-ray separation, and final hand sorting.
- Together with Sedelingsdrif, the MA1 produced 330 196 carats in 2021.

2.5.2 Sendelingsdrif

- The Sendelingsdrif Mine is located along the Orange River approximately 80 km inland from Oranjemund and 20 km south of Rosh Pinah. It started to produce in 2014.
- The ore comprises diamondiferous gravels of a proto-Orange River terrace.
- The ore is mined in an open cast operation employing overburden removal, waste stripping, excavation, and loading and hauling. Blasting is necessary only when cemented layers are encountered. Manual bedrock cleaning with transvacs is used in some areas.
- The treatment plant consists of a dry screening process, dense medium separation, and X-ray separation. The concentrate is transported to Oranjemund for final hand-sorting.
- Together with MA1, Sendelingsdrif produced 330 196 carats in 2021.

2.5.3 Elizabeth Bay

- The Elizabeth Bay mine is located some 25 km south of Lüderitzbucht, and has been in operation intermittently since 1926, when it had one of the most modern processing plants in the World. Since 2020, it has been operated by Sperrgebiet Diamonds, however only on a care and maintenance basis, while modifications to the operations are undertaken.
- The ore consists of 1 to 4 m thick unconsolidated diamondiferous sands and gravels underlain by 2 m of diamondiferous cemented gravels.
- The ore was and will be mined by conventional open cast techniques employing hydraulic excavators, loading and hauling with articulated dump trucks.
- The ore was and will be treated in a plant employing crushing, screening, scrubbing, dense medium separation, X-ray separation and final hand sorting.
- There has been no production in the last 2 years, but it is anticipated that production will resume in September 2022. Past production was around 200 000 carats annually.

2.5.4 Debmarine Namibia

- Debmarine Namibia operates a large offshore license area of some 600 000 ha, termed Atlantic 1 to the west of Namdeb's Minig Area 1. A fleet of six production vessels is responsible for about 70% of Namibia's diamond production. Exploration is carried out by a

dedicated exploration vessel. Mining takes place on the sea floor at water depths of up to 140 m.

- Namibia's marine diamond deposits on the continental shelf have a complex sedimentary history involving introduction of the diamonds by fluvial systems and subsequent reworking by marine coastal and nearshore processes during times when the sea level was lower.
- Two mining technologies are deployed to suit different ground conditions, namely airlift-drill technology, which uses a 6.8 m diameter drill bit working in overlapping circles on the sea floor; and the crawler technology, which uses a 280 t track-mounted crawler dredging the sea floor.
- Processing of the ore takes place in recovery plants on board the ships employing screening, dense medium separation and X-ray separation. The resulting concentrate is transported by helicopter to Oranjemund for final hand sorting.
- In 2021, Debmarine Namibia produced 1 136 000 carats of diamonds.

2.6 Tin

Namibia has a large variety of tin deposits, which have been mined on different scales since the colonial days. However, the only large-scale production took place at the Uis and Brandberg West Mines, of which only Uis is still in operation today.

2.6.1 Uis

- The Uis Tin Mine is located some 28 km east of the Brandberg Complex, and has intermittently been mined since 1911. Up to 1990 it was operated by the South African company ISCOR, during which time it was the largest hard-rock tin mine in the World. It was re-opened in 2018 by the current operator AfriTin.
- The ore comprises of unzoned, coarse-grained pegmatites carrying disseminated cassiterite mineralisation, and belonging to the rare-metal bearing pegmatite type.
- Mining is conducted in a conventional open pit operation with drilling, blasting, loading and hauling equipment.
- The processing plant has a complex set of crushers, namely a primary, a secondary and a tertiary crusher, followed by 2 quaternary crushers, taking the ore to -6 mm. Thereafter it passes through two stages of dense medium separation and finally shaking tables, resulting in a concentrate of 62%+ tin.
- The potential of producing lithium and tantalum as a by-product is currently under investigation.
- In 2021, the Uis Tin Mine produced 784 t of tin concentrate.

2.7 Lithium

Namibia also has a large variety of lithium deposits, which have been mined on different scales since the colonial days. However, the only large scale production has taken place at the Rubikon and Helikon Mines, which are currently in preparation for re-opening by Lepidico.

2.7.1 Rubikon + Helikon

- The Rubikon and Helicon Mines are situated on farmland some 30 km southeast of Karibib. They were mined in the past between 1951 and 1992.

- The ore comprises of highly differentiated pegmatites of the internally zoned lithium-caesium-beryllium-rubidium pegmatites, well known for the highest degree of alkali fractionation. Lithium ore minerals include lepidolite, petalite and amblygonite.
- Selective mining occurred in open pit, as well as underground open stoping operations, employing drilling, blasting, loading and hauling.
- After the re-opening, the operation with be open pit only.
- Beneficiation was mainly done by screening and hand sorting, however, a lepidolite flotation plant was in operation for some time at Rubikon.
- Lepidico has patented processes to produce both lithium carbonate and lithium hydroxide from hard-rock lithium-bearing minerals, and intends to erect a chemical plant for that purpose. Furthermore, caesium and rubidium contained in these lithium minerals are amenable to processing too by the company's proprietary technologies.

2.8 Iron

Namibia has not been a traditional iron ore producer, but its first iron ore mine, although first investigated in the 1950s, came into small scale production only in 2015, and is ramping up since. It is operated by Lodestone Namibia.

2.8.1 Dordabis

- The Lodestone Iron Mine is located near Dordabis, some 60 km southeast of Windhoek.
- The ore comprises of banded iron formation containing hematite and magnetite.
- Mining is conducted in a conventional open pit operation employing drilling, blasting, loading and hauling.
- Once fully operational, the plant will produce a 66% iron concentrate by screening, crushing, grinding, and gravity separation.
- In 2021, Lodestone produced 75 718 t of iron ore.