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Geology of the Skorpion Supergene Zinc Deposit, Southern Namibia

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Abstract

The Skorpion zinc deposit in southwestern Namibia comprises a significant nonsulfide orebody (24.6 Mt at 10.6% Zn) and subordinate amounts of primary base metal sulfide mineralization, which structurally underlies the nonsulfide ores at depth. The host rocks of the blind, nonsulfide orebody and relict sulfide mineralization consist of a mixed volcano-sedimentary sequence of Neoproterozoic age that has formed in an initial continental rift system between the Kalahari cratonic province and the Rio de la Plata cratonic province. The metavolcanic and subvolcanic rocks display a distinct bimodal geochemical composition of within-plate affinity and have been emplaced under an extensional crustal regime. Zircons from a rhyolitic vesicular flow, extruded approximately contemporaneously with the volcanic-hosted sulfide mineralization, have been dated by SHRIMP U-Pb analysis and yield an age of 751.9 ± 5.5 Ma.

The basin that hosts the Skorpion deposit has been shaped by horst and (half-)graben tectonics, which also controlled the sedimentary deposition of siliciclastic and carbonate sediments within both shallow and deeper water environments. The rock sequence was affected by a major tectono-metamorphic event the Pan African-Brasiliano orogeny at approximately 550 to 545 Ma. Metamorphism reached uppermost greenschist to lowermost amphibolite facies, and the complex deformational style of the region is the result of intense faulting, folding, and thrusting.

The Skorpion orebody is hosted by arkosic metaarenites and subordinately by volcaniclastic metasedimentary rocks. It is irregularly shaped, transgressive to sedimentary layering, and has a relatively flat top, which is covered by a blanket of unmineralized overburden consisting of calcrete, boulder beds and recent sand dunes. At depth, the orebody has a relatively sharp contact with a barren marble unit on the east and south and a more gradational boundary within the siliciclastic host rocks on the west and north. The nonsulfide ore minerals comprise predominantly sauconite (Zn smectite), substantial amounts of hemimorphite and smithsonite, and subordinate amounts of scholzite, tarbuttite, atacamite, hydrozincite, and hetearolite. The ore minerals are mainly euhedral and subhedral crystals and occur as open space fillings in intergranular voids, fractures, and breccias and as replacements of feldspar and mica. The metasedimentary host rocks of the nonsulfide ore contain abundant iron hydroxide pseudomorphs after disseminated sulfides and stringers and after rare semimassive stratiform layers of sulfides. Gossanous, manganese and iron hydroxide-rich, siliciclastic, metasedimentary rocks are common in the western and northwestern vicinity of the nonsulfide orebody. Alteration of the supergene mineralized host rocks includes removal of calcite cement and the breakdown of detrital albite-rich plagioclase and of minor orthoclase. Local alteration phenomena also include silicification and rare secondary barite, both a result of the alteration and breakdown of feldspar.

Minor base metal sulfide mineral deposits occur in metarhyolitic flows and felsic hyaloclastic rocks, structurally below the nonsulfide orebody. The primary sulfide minerals comprise pyrite, pyrrhotite, sphalerite, minor chalcopyrite, and galena as well as secondary chalcocite and colloidal sphalerite (brunckite). The volcanic-hosted sulfide ore minerals are deformed and partly recrystallized and thus of premetamorphic and predeformation origin.

In contrast, the Skorpion nonsulfide zinc deposit is of postmetamorphic origin, as shown by two hydrous, low-P, low-T ore assemblages. The secondary assemblages occur, at least partly, as delicate euhedral and subhedral crystals in secondary pore space, open fractures, veins, and breccias. The nonsulfide ore contains pseudomorphs from in situ oxidation and replacement of preexisting sulfides and ore and also from the remobilization or precipitation of base metals.

The Skorpion nonsulfide zinc deposit is of supergene origin and formed from the oxidation of sulfide protore by circulating meteoric water, as suggested by textural evidence and by initial stable isotope data. The timing of ore formation is still undefined but lies within the large age bracket between 545 Ma (peak metamorphism) and subsequent partial exhumation and the deposition of the nonmineralized overburden of Namib Desert gravels (<21 Ma) and dune sands.

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