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## Geology, Geochemistry and Zonation of the Tsumeb Polymetallic Deposit

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The Tsumeb polymetallic sulfide deposit, in the Otavi Mountain Lands (OML), has a reported resource of 29 Mt of ore at an average grade of 4.3 % Cu, 10 % Pb, 3.3 % Zn, 600 g/t Cd, 450 g/t Mo, 125 g/t Ge, and 98 g/t Ag, and is the largest of similar deposits in the OML, in northeast Namibia, but relatively small by international comparison but was formally Africa's largest producer of lead. The iconic status of Tsumeb relates to the presence of over 400 known minerals in the different mineralized assemblages. The deposit is situated in a fold-thrust belt along the northern margin of the Pan-African Damara Belt hosted in carbonate rocks. Mineralization was structurally controlled, within a pipe-like structure with ore occurring as breccias. Mineralization is estimated to have formed from fluids at temperatures between 370 and 400 $^{o}$C from highly saline fluids (20 – 25 wt.% $NaCl_{eq}$). Secondary inclusions have lower salinity pointing towards increasing contribution from meteoric waters. Metals are most likely from Grootfontein metamorphic complex. This unconsolidated but coarse karst fill formed prior to migration of orogenic brines. Hydraulic overpressure of these brines led to mechanical redistribution of the still loose sand and rock fragments in the karst cavities, resulting in favourable structures to host mineralization as well as intense hydrothermal alteration. A unique feature of the deposit is the presence of multiple oxidation zones related to major fractures that allowed migration of meteoric water into deeper portions of the deposit. A complex mineral paragenesis exists and shows zonation with higher Pb contents near surface, Zn and Ge concentrated in the middle depths, and Cu and Ag contents increasing with depth (over 1700 m). Supergene oxidation was not the result of a single, geological event but of multiple episodic events over time.