

Dual Horizon Ni-Cu-PGE Mineralisation in the Deep Platreef, Mogalakwena Mine Complex, South Africa: Insights into Formation of High PGE Tenors

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Multiple mechanisms can generate high PGE tenors in magmatic sulfide deposits. However, for the Platreef Ni-Cu-PGE deposit in the Northern Bushveld Complex, South Africa, there is still no widely accepted mechanism. The down-dip extension of the Platreef at Sandsloot, Mogalakwena Mine Complex, hosts two distinct mineralised subunits: the Pt+Pd-rich PGE-Reef and, approximately 150 meters below, the Base Metal Zone (BM Zone), which is Fe-Ni-S-rich and newly recognised as being enriched in IPGE(Os-Ir-Ru)+Rh. The PGE-Reef contains Pt+Pd tenors up to 1900 ppm, while the underlying BM Zone contains IPGE+Rh tenors up to 1300 ppm – making this a prime area to evaluate mechanisms of high tenor formation.

Previous work has shown the BM Zone likely represents the monosulfide solid solution (MSS) portion of a sulfide liquid, whereas the PGE-Reef reflects a more typical sulfide liquid. In the PGE-Reef PGEs are predominately contained within Pd-rich pentlandite, symplectitic Pt-Fe PGM, and Pt±Pd-Bi-Te PGM. Interaction with country rock dolomite elevated fO_2 in the PGE-Reef, promoting the formation of high-temperature magmatic Pt-Fe alloys. Subsequent interaction with carbonate- and Pb-Zn±Cl-rich hydrothermal fluids modified the PGM and sulfide assemblage. $\delta^{34}S$ values (relative to VCDT) of +1.0 to +3.4 ‰ support a dominant magmatic origin to the sulfide liquid, with heavier values towards the footwall and around calc-silicate xenoliths suggesting contamination.

We propose the PGE-Reef and BM Zone represent two distinct generations of sulfide liquid. Their high PGE tenors are interpreted as primarily magmatic in origin, controlled by high R-factor and proximity to a feeder zone. The MSS-associated sulfides of the BM Zone preserve evidence of an early, ultra-high-tenor sulfide liquid, while fluid interaction modified sulfide and PGM in the PGE-Reef. These findings elucidate the complex interplay of magmatic and fluid processes that govern ore mineralogy and metal tenors in the deep Platreef.