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The Mineralogy of PGE in the Deep Critical Zone at Sandsloot, Northern Bushveld Complex, South Africa: PPGE Reef Underlain by an IPGE + Rh-Rich Base Metal Zone

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The Bushveld Complex, South Africa, is home to some of the world's largest magmatic sulfide deposits. Recent discoveries, including the down-dip extension of the Critical Zone (CZ) hosted Platreef PGE-Ni-Cu deposit, have positioned the Northern Limb of the Bushveld Complex as a frontier for PGE+Ni+Cu+Co exploration and mining in the future decades. In the Sandsloot area, the near-surface resources of the CZ are well characterised, but the recently discovered down-dip extension is not; where multiple high-grade PGE-rich zones on the scale of 10s of meters are underlain by thick base metal sulfide-rich zones. In this study we utilise PGE geochemistry, sulfide and PGM studies and S isotopes to establish the relative controls on the distinctive metal budgets of these two zones.

The PGE reef has 1-2 modal.% disseminated sulfides and is Pt+Pd+Rh(PPGE)-rich. The PGE is dominantly contained within Pt-Fe-alloys, Pt-Pd-(Pb)-bismuthotellurides and Pt-Pd-Pb-alloys, along with high Pd (<3500 ppm), Rh (<270 ppm)-bearing pentlandite. In contrast, the lower base metal (BM) zone contains higher volume, blebby to semi-massive sulfides and lower Pt+Pd grades, but significantly, high Os+Ir,+Ru(IPGE)+Rh. The PGE is predominately contained within sulfide hosted Ir-(Os)-arseno-sulfides and Ru-sulfide (62%), as well as Ru, Rh-rich (<55, 300 ppm) pentlandite and Ru-rich (<45 ppm) pyrrhotite. Within the PGE reef $\delta^{34}S$ values (+0.7-+2.4 ‰), in addition to S/Se ratios (3100-1200), reveal a magmatic control, with subsequent S-loss through fluid mobilisation. In contrast, the underlying BM zone displays an isotopically heavier, contaminated, signature (+4.2-+7.5 ‰).

The difference in PPGE to IPGE+Rh between the PGE reef and BM zone represents a disconnect between the zones. Understanding the PGE mass balance of the deep CZ at Sandsloot, along with the association of PGM and sulfide to surrounding minerals aids not only with understanding of the ore's genesis, but additionally, early understanding of geo-metallurgy has implications for processing.