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Magmatic Stratigraphy of the Deep Platreef at Sandsloot, Northern Bushveld Complex: Carbonate Contamination and Controls on Ni-Cu-PGE Mineralisation

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The Platreef, northern limb of the Bushveld Complex, South Africa, is widely regarded as one of the world's largest resources of platinum-group elements (PGE). These PGE, as well as significant amounts of base metals (Ni, Cu, Co) also found in the northern limb, are essential for the growth of many sustainable and environmentally friendly technologies. The Platreef is part of a complex package of Critical Zone (CZ) rocks which differ from the wider Bushveld in that high grade PGE mineralization is spread over a much greater thicknesses compared to the Merensky Reef. Additionally, it lies north of the Thabazimbi-Murchison lineament, and rests directly on the metasedimentary Transvaal Supergroup. The resulting footwall interactions are known to have had a significant impact on the fluctuating geochemical and mineralogical signatures of the northern limb magmas, as well as their Ni-Cu-PGE grades.

In this study, the petrology, bulk geochemistry, including Nd-Sr-Hf-Pb isotopic compositions, and silicate mineral chemistry of samples from the Platreef at Sandsloot are examined, with the aim of establishing the magmatic stratigraphy of the deeper Platreef, down-dip from the Mogalakwena open pit. Here, the Platreef is composed of up to five pyroxenitic packages, with significant PGE and base metal mineralisation observed in two. Varying CaO/Al_2O_3, and Eu/Eu* ratios, Pb and Sr anomalies are associated with different units and allude to varying degrees of contamination. Variations in the parental magma compositions for each of the identified units are more difficult to distinguish. Hybrid skarn textures are observed within the Base Metal Zone (BMZ), indicating the importance of interactions with the underlying Malmani Dolomite in forming economic Ni-Cu-PGE mineralisation at this location. Significant PGE mineralisation is also commonly accompanied by extensive hydrothermal alteration, which is not observed in barren units, and suggests that rock-fluid interactions may be key to concentrating PGE grades at Sandsloot.