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Disseminated PGE-Cu-Ni sulfide mineralization within the Rietfontein deposit, Eastern Limb, Bushveld Complex, South Africa: Implications for formation of Platreef-style PGE deposits

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The Rietfontein PGE-Cu-Ni sulfide deposit, which occurs in the Eastern Limb of the Bushveld Complex, is mineralogically and geochemically similar to the economic deposits of the Platreef within the Northern Limb of the Complex. The host rocks of the mineralization are mainly norites and gabbronorites together with lesser amounts of plagioclase-bearing ultramafic rocks. The norites occur mainly at the base of the sequence and are overlain by thick sequences of gabbronorites intermixed with narrow intervals of norite and plagioclase-bearing ultramafics. The most common footwall rocks at Rietfontein are fine grained hornfelsed pelitic and quartzose sediments with lesser amounts of coarse grained massive chloritic-cordierite hornfels, and rare recrystallized calc-silicate units. Xenoliths of the footwall rocks are very common in the intrusive rocks. The norites are dominated by cumulus low Mg# orthopyroxenes that are accompanied by both cumulus and intercumulus plagioclase. The gabbronorites are dominated by high Mg# orthopyroxene, with lesser amounts of cumulus chromite and olivine and intercumulus clinopyroxene and plagioclase. The parental magma to these rocks had a similar trace element pattern to that which formed the Platreef and carries a strong crustal contamination signature.

Although PGE grades at Rietfontein are similar to those of the Platreef, the mineralized intersections are much narrower. The mineralization occurs at the contact of the gabbronorites with the underlying norites; the basal norites are believed to have been emplaced before the gabbronorites as a separate pulse of magma. This suggests that the PGE-rich sulphides were introduced with the gabbronorite magmas, settling at or near the norite-gabbronorite interface once the capacity of the magma to entrain sulphides was significantly reduced. The presence of some samples with S/Se ratios > 4500 (the upper limit of the mantle S/Se range) indicates that a significant source of S in the sulphides is crustal S. As with the Platreef, there is a strong inverse correlation between PGE tenors and S/Se ratios. This suggests that the PGE-rich sulphides were formed at depth in a staging chamber and then transported by the gabbronorite magma, which may initially have been S-undersaturated. During transport, the sulphides were partially resorbed by the magma, taking Fe and S back into the magma. Those elements with high sulphide melt/silicate melt partition coefficients such as Pd, Pt, Au, Cu and Se were concentrated in the residual sulphides. The development of economic PGE mineralization is controlled by a magma's "carrying capacity", which is determined by the magma's energy, flow rate and style, viscosity, and phenocryst content. The high xenolith content of the Rietfontein rocks attests to the high energy of it's parental magma, thus enabling it to carry a significant phenocryst load and in turn transport PGE-rich sulphides