

PGE Behavior During Serpentinization of Ultramafic Sequences in the Bushveld Large Igneous Province

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Behavior of magmatic sulfides and associated platinum-group minerals (PGMs) during serpentinization can be highly variable depending on the PT conditions of the process. The S isotope composition of interstitial sulfides in the ultramafic zones of the Bushveld northern limb and Molopo Farms Complex indicates crustal S contribution to the parental S undersaturated siliceous komatiitic magmas. Primary PGE distribution in all mineralized ultramafic rocks is characterized by a typical Bushveld-type pattern albeit with a pronounced Pt negative anomaly and a lower level of PGE enrichment roughly proportional to a reduced proportion of interstitial liquid in accumulates. In contrast, chromite-rich rocks have a distinct flatter PGE pattern thought to result from preferential crystallization of Os, Ir and Ru compounds with respect to Pt, Pd and Rh phases within the zone of massive chromite precipitation. Three different types of PGE and base metal redistribution are observed in the studied serpentinized varieties. In chromite-poor rocks from Uitloop and Grasvally remobilization is limited to microscale replacement. In Grasvally chromite-rich rocks, a primary pyrrhotite-pentlandite association is mostly dissolved and replaced by secondary heazlewoodite and pentlandite, whereas only Ir-Os-Rh-Pt sulfarsenides are mainly preserved among the PGM relics in secondary sulfides. In Molopo Farms serpentinites, a secondary Ni sulfide-alloy-arsenide assemblage replaces primary sulfides with liberated PGE stabilized as solid solutions in secondary Ni arsenides. Secondary mineralization of all three types is depleted in Cu and enriched in Ni, which is derived from dissolution of both sulfides and silicates, and is mostly concentrated in secondary ore minerals. The PGE capture by arsenides, preventing their dissipation, is facilitated by a superimposed relatively high-temperature hydrothermal event as seen in the Molopo Farms mineral assemblages, whereas serpentinization on its own results in loss of noble metals while gaining Ni.