

Use of chromite chemistry for correlation of PGE-bearing reefs within the Bushveld Igneous Complex

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The Paleoproterozoic Bushveld Igneous Complex, the largest known igneous complex on Earth, consists of four igneous rock suites; the most studied is the Rustenburg Layered Suite (RLS), which contains the largest platinum group element (PGE) reserves in the world. The RLS cumulate rocks have exposure at three limbs: eastern, western, and northern. These limbs host PGE mineralization in layers called 'reefs', namely: UG-2, Merensky Reef, and Platreef. The western and eastern limbs host PGE ores within the UG-2 (massive chromite) and Merensky (chromite- and sulfide-bearing pyroxenite) reefs, whereas ores in the northern limb are associated with the Platreef (a suite of chromite- and sulfide-bearing pyroxenites). Platreef and massive chromitite seams below it have recently been hypothesized to be the lateral equivalents of the Merensky and UG-2 reefs, based on similar stratigraphy and gravity surveys. Because chromite is a key cumulate mineral in all the reefs, this project is investigating whether chromite chemistry could be used to test this hypothesis. In this context, chromitite samples were collected from UG-2 and a massive chromitite below Platreef that is interpreted as the 'UG2 cyclic unit', and were analyzed to determine if there is a correlation in chromite chemistry. Chromite is the term used to describe spinel-group minerals ($X^{2+}(Y^{3+})_2O_4$), and is assumed to be one of the first phases to crystallize. Chromium number (Cr#) [$Cr/(Cr+Al)$] and magnesium number (Mg#) [$Mg/(Mg+Fe^{2+})$] are representative of the Cr-Al and Mg-Fe²⁺ substitutions in chromite. Fluctuations in these variables may indicate changes in magma composition that result, for example, from repeated magma injections during fractional crystallization. Chromite composition can also be affected by late or post magmatic processes such as: 1) chromite interaction with intercumulus magmatic liquid, 2) post-cumulus diffusive equilibration (e.g., Fe, Cr, Mg, and Al transfer between chromite and surrounding silicates), 3) Fe-exchange between chromite and sulfides, and 4) chromite alteration by hydrothermal fluids. Chromite composition (i.e. Mg # and Cr #) can also be used to infer the mechanism of chromitite accumulation (e.g., settling vs. slurries). Preliminary results, based on electron microprobe analysis of samples from the UG-2 and UG2 cyclic unit, as well as data compilation from the literature for the three reefs, show distinct and, in some cases, overlapping compositional fields for the reefs. Ongoing work will use trace element contents in UG-2 and UG2 cyclic unit samples as additional discriminants to test possible correlations.