

The Role of fO_2 and Chromium Content in Chromite Saturation: Experimental Insights from Primitive Bushveld Magmas

Caitlynn Van Wyk¹, Gary Stevens¹

¹Stellenbosch University, Stellenbosch, South Africa

The formation of massive chromitite layers in the Bushveld Igneous Complex requires rapid and efficient chromite saturation from evolving magmas, yet the physicochemical triggers for this process remain unresolved. Existing models propose magma mixing, depressurization, or redox changes, but the relative importance of oxygen fugacity (fO_2) versus chromium enrichment remains unclear.

This study presents a controlled experimental framework designed to quantify the effects of fO_2 and melt composition on chromite stability. Synthetic starting materials based on a representative B1 composition (and other mafic/ultramafic compositions) are doped with Cr_2O_3 and equilibrated at high temperatures across a range of fO_2 conditions using a gas-mixing furnace. Experiments are conducted using wire-loop techniques (after Murck and Campbell, 1986) to enable simultaneous investigation of multiple compositions, with run products analyzed using scanning electron microscopy. Preliminary thermodynamic modelling using MAgEMin predicts a strong sensitivity of chromite saturation to both redox conditions and bulk chromium content, with distinct stability fields emerging across the investigated parameter space. These models guide experimental design and provide a framework for interpreting run products.

The results of this study will provide new constraints on the physicochemical conditions required for chromitite formation in Bushveld-type systems. By systematically isolating the effects of fO_2 and chromium availability, this work contributes to a more robust framework for understanding spinel saturation and ore formation in layered intrusions, with broader implications for magmatic Ni-Cr-PGE systems.