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The emplacement mechanism of the UG-1 chromitite in the Bushveld Complex, South Africa

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The UG-1 chromitite hosted by the Bushveld Complex (2.06 Ga) is a great attraction to petrologists because of its unique association with anorthosite with which it is spectacularly interlayered, and for its bifurcations [1, 2]. The UG-1 refers to a massive layer (0.8-0.9 m thick) of chromitite as well as numerous sublayers (10s of cms to mm) that are hosted by anorthosite in the footwall; anorthosite containing pyroxene mottles, and devoid of chromitite, occurs below this unit. The massive UG-1 is overlain by pyroxenite with which it has a gradational contact. This study aims to understand the development and emplacement of the massive UG-1 layer as well as the sublayers in anorthosite.

Field observations in this study significantly bear insight on the mechanism of UG-1 emplacement. Field work has been conducted in the Anglo-Platinum School of Mines (Rustenburg area, Western Bushveld) where the UG-1 is exposed at depths of 350 m and 450 m. The most telling field observations are: *(a)* a ≈1 m thick massive UG-1 with intervening pyroxenite layer, *(b)* dimpled erosive boundaries of remnant anorthosite layers within massive UG-1, *(c)* often parallel dispositions of thinner (few cm-scale) bifurcating UG-1 sublayers in anorthosite, *(d)* transgressive relationship between pyroxene oikocryst-defined layering and UG-1 sublayers in anorthosite, and *(e)* trails of remnant anorthosite lenses with erosive dimpled boundaries within UG-1 sublayers in anorthosite.

Field observations have been combined with bulk rock geochemical study (conducted on two drill cores), and chromite chemistry (using electron probe on samples collected from the underground mine), to provide further insights into the development of UG-1. Major element variations indicate that the massive UG-1 layer formed through at least 3 cycles of magmatic replenishments. The underlying chromitite sublayers in anorthosite represent separate magmatic events. The major element variations also indicate a gradation from orthocumulate to adcumulate textures and vice-versa through the massive UG-1 unit. Platinum-Group Elements (PGE) in most cases increase with adcumulate nature of the chromitite in both drill cores. The Iridium-Group PGEs (IPGE) show good correlation with one another and with sulfur indicating that they occur mostly as alloys, and in sporadically occurring sulfides contained in the chromitite. Palladium-Group PGEs (PPGE) occur in sulfides, but Rh and Pt may occur as alloys with IPGEs. Electron probe microanalysis of chromites indicates variations in composition between the bifurcating chromitite branches, e.g. an increase in Al_2O_3 (by 3 wt%), MgO (by 1 wt%) & decrease in FeO (by 9 wt%), Cr_2O_3 (by 1 wt%) and TiO_2 is observed from the lower bifurcating branch towards the upper branch.

The bulk-rock geochemistry and chromite composition imply that multiple magmatic events were responsible for formation of the UG-1. However field observations are more critical in understanding the emplacement mechanisms for the UG-1. The occurrence of a ≈ 1m thick massive UG-1 layer indicates that it formed from chromite-saturated magma that was emplaced as basal flows along the magma chamber floor. Parallel dispositions of the bifurcating chromitite sublayers indicate structural control and, together with features like lens-shaped anorthosite lenses with dimpled boundaries, and transgressive relationship of pyroxene oikocrysts imply that the UG-1 sublayers in anorthosite were likely emplaced as sills into the anorthosite footwall, through fractures that formed during the magma emplacement process. The preferred model to explain all the various textural features of the UG-1 is to incorporate the possibility of both emplacement mechanisms to be occurring in conjunction to form the UG-1 chromitite in the Bushveld Complex.

References:

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