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Partial assimilation of calc-silicate xenoliths in the Uitkomst Complex, South Africa

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The Uitkomst Complex is located in the Great Escarpment in the Mpumalanga Province of South Africa. The intrusion is a layered ultra-mafic to mafic conduit deposit, related to the Bushveld Complex. The Uitkomst Complex is comprised of a basal unit and a main unit. The basal unit, from the bottom upwards comprises of the: Basal Gabbro (BGAB), Lower Pyroxenite (LrPXT), Chromitiferous Periodotite (PCR) and the top is marked by the Massive Chromite (MCR) layer. The main unit consists of the: Main Harzburgite (MHBG), Upper Pyroxenite (UPXT) and Gabbro-norite (GN) and upper Gabbro (UGAB). The host rocks are the chemical and clastic sediments of the Transvaal Supergroup. The basal units of the intrusion are hosted by the Malmani dolomite and calc-silicate xenoliths from this formation are present in the Lower Pyroxenite. The main units are hosted by the Timeball Hill shale and quartzites.

Core samples from the BGAB, LrPXT and PCR were submitted for geochemical and mineralogical analyses. Electron Microprobe (EMP) analyses of the olivine indicated two distinct species in the PCR unit and only one in the LrHZB unit. The PCR contains diopside-augite and enstatite pyroxene species. The LrHZB contain diopsite-augite and Ca-Tshermak (CaTs) diopside species and the calc-silicate xenoliths are dominantly composed of CaTs-diopside. EMP analyses of the diopside found the PCR diopside to be more Cr-rich than in the LrHZB. The CaTs-diopside in the xenoliths is more Mn-rich than those in the LrHZB. Plagioclase is present in the wehrlite layers of the LrHZB, but absent in the other layers of this unit. Addition of calcium to a magma results in CaTs-diopside being formed at the expense of plagioclase.

The PCR is extensively replaced by secondary talc-carbonate assemblages. This would suggest the PCR was subjected to a CO_2-rich deuteric fluid alteration event. The LrHZB in turn is extensively amphibolised. Two generations of amphibole are observed, a primary amphibole assemblage and a secondary amphibole assemblage. This would suggest a water-dominated deuteric fluid alteration of the primary assemblages.

The basal sequence appears to be inverted, with the bottom of the unit grading from a gabbro to a pyroxenite, overlain by a harzburgite and capped by a chromitite layer. This would suggest that emplacement of the basal units of the conduit was from the top down. The sequence of the main unit follows the normal magmatic diffraction. The hypothesis is that the conduit intruded between the dolomite and shale contact. The PCR would have been emplaced first, and interacted with the dolomite country rock. The devolatilization of the dolomites would also account for the CO_2-rich deuteric fluid that resulted in the extensive hydrothermal alteration of the PCR unit. This also generated the calc-silicate skarn at the bottom of the intrusion. This was then followed by the emplacement of the LrHZB magma, where the mineralogy and viscosity of the intruding magma was affected by the CO_2-rich emplacement environment. The CaTs-diopside in the LrHZB is indicative of partial calc-silicate assimilation by the magma. Assimilation was also enhanced by the containment of the calc-silicate

xenoliths in the bottom of the conduit and could not be as effectively removed from the system as observed or modelled in other conduit or magmatic emplacement environments.