# Alteration assemblage in the lower units of the Uitkomst Complex, Mpumalanga Province, South Africa.

by

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# DECLARATION

I, **Nicolaas Casper Steenkamp**, hereby declare that this thesis that I hereby submit for the Degree DOCTOR PHILOSOPHIA (PhD) at the University of Pretoria is my own work has not previously been submitted by me for a degree at this or any other university.

**Signature: ____________________** **Date: ______________**

**Abstract**

The Uitkomst Complex is located within the Great Escarpment area close to the town of Badplaas, approximately 300 km due east of Pretoria, in the Mpumalanga Province, South Africa. This complex is believed to represent a layered conduit system related to the 2.06 Ga Bushveld Complex. The succession from the bottom up comprises the Basal Gabbro- (BGAB), Lower Harzburgite- (LHZBG) and Chromitiferous Harzburgite (PCR) Units, collectively referred to as the Basal Units, followed by the Main Harzburgite- (MHZBG), Upper Pyroxenite-(PXT) and Gabbronorite (GN) Units, collectively referred to as the Main Units. The Basal Unit is largely hosted by the Malmani Dolomite Formation, in the Pretoria Group of the Transvaal Supergroup sediments. The Lower Harzburgite Unit contains numerous calc-silicate xenoliths derived from the Malmani Dolomite.

The Basal Units host the economically important nickel-bearing sulphide and chromite deposits exploited by the Nkomati Mine. An area of extensive localized talc-chlorite alteration is found in the area delineated for large scale open cast mining. This phenomenon has bearing on the nature and distribution of the sulphide minerals in the Chromitiferous Harzburgite and to a lesser extent the Lower Harzburgite Units.

The Basal Unit is comprised of both near pristine areas of mafic minerals and areas of extensive secondary replacement minerals. Of the olivine minerals, only fosterite of magmatic origin is found, the fosterite suffered hydrothermal alteration resulting in replacement of it by serpentine and secondary magnetite. Three different types of diopside are found, the first is a primary magamatic phase, the second is a hybrid “transitional” phase and the third, a skarn phase. Hydrothermal alteration of the matrix diopside led to the formation of actinolite-tremolite pseudomorphs. This secondary tremolite is intergrown with the nickeliferous sulphide grains. Chromite grains are rimmed or replaced by secondary magnetite. Pyrrhotite grains is also rimmed or replaced by secondary magnetite. Talc and chlorite is concentrated in the highly altered rocks, dominating the PCR unit. Primary plagioclase and calcite do not appear to have suffered

alteration to the same extent as the other precursor mafic magmatic and hydrothermal minerals.

It is suggested that the PCR was the first unit to be emplaced near the contact of the dolomite and shale host rock. The more primitive mafic mineral composition and presence of chromitite attest to this interpretation. The LHZBG and MHZBG units may have been emplaced simultaneously, the LHZBG below and the MHZBG above. Interaction and partial assimilation of the dolomitic country rock led to a disruption of the primary mafic mineralogy, resulting in the preferential formation of diopside at the expense of orthopyroxene and plagioclase. Addition of country rock sulphur resulted in sulphur saturation of the magma and resulted in the observed mineralization. The downward stoping of the LHZBG magma, in a more "passive" pulse-like manner led to the formation of the calc-silicate xenolith lower third of this unit.

It is proposed that the interaction with, and assimilation of the dolomitic host rock by the intruding ultramafic magmas of the Basal Units are responsible, firstly, for the segregation of the nickeliferous sulphides from the magma, and secondly for the formation of a carbonate-rich deuteric fluid that affected the primary magmatic mineralogy of the Basal Unit rocks.

The fluids released during the assimilation and recrystallization of the dolomites also led to the serpentinization of the xenoliths themselves and probably the surrounding hybrid and mafic- ultramafic host rocks. The $CO_2$-rich fluids migrated up and outward, while the $H_2O$-rich fluids remained confined to the area around the xenoliths and LHZBG unit. The $H_2O$-rich fluid is thought to be responsible for the retrograde metamorphism of the precursor magmatic and metamorphic minerals in the Lower Harzburgite Unit. The formation of an exoscarn within the dolomitic country rocks and a selvage of endoskarn on the contact form an effective solidification front that prevented further contamination of the magma. It is also suggested that these solidification fronts constrained the lateral extent of the conduit.

The $CO_2$-enriched deutric fluid was able to migrate up to the PCR unit. Here the fluid was not removed as effectively as in the underlying parts of the developing conduit. This resulted in higher $CO_2$-partial pressures in the PCR unit, and the stabilization of talc-carbonate assemblages that extensively replaced the precursor magmatic mineralogy.

Intrusion of the magma into the shales, which may have been more susceptible to assimilation and greater stoping, led to a broadening in the lateral extent of the Complex, in the Main units above the trough-like feature occupied by the Basal Units.

Late-stage, hydrous dominated fluid migration is inferred to have been constrained to the central part of the conduit. This is demonstrated by the dominance of chlorite in the central part of the Uitkomst Complex in the study area. The Uitkomst Complex was further deformed by later intrusions of dolerite dykes. Weathering of the escarpment led to exposure of the conduit as a valley and oxidation of the surficial exposed rocks.

*[810 words].*

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