2. PREVIOUS WORK

The Uitkomst Complex was first mentioned by Wagner in 1929 who described the intrusion as a "big sill of highly altered pyroxenite carrying platinum in association with magnetic iron sulphides". He proposed that the body was of Archaean age and possibly related to mafic rocks of the Barberton area. The sulphides, mainly pyrrhotite, pentlandite and chalcopyrite, were described as being "interstitial and molded on the silicates".

Kenyon *et al*. (1986) completed the first geochemical examination of the Complex concentrating on the chromitites from the ultramafic zone. Based on S/Se ratios they suggested that the main source of the sulphide mineralization was magmatic and that the Complex may have been emplaced by injection of different pulses of magma. The close spatial association of the sulphide mineralization with the dolomites of the Transvaal Sequence was explained by release from the dolomites of CO_2 on interaction with the magma. The resulting increase in oxygen fugacity along with the associated decrease in FeO resulted in sulphide supersaturation and sulphide segregation followed by chromite crystallization. The presence of numerous dolomitic xenoliths in the ultramafic rocks led Kenyon *et al*. (1986) to believe that the Uitkomst magmas thermally eroded the host Transvaal sedimentary rocks. Based on similarities in chromite composition Kenyon *et al*. (1986) postulated a genetic link between the Uitkomst Complex and the Bushveld Complex, a link that had earlier been proposed by Sharpe *et al*. (1981).

Allen (1990) suggested emplacement of the Complex by injection of three compositionally different pulses of magma. Her study was based on the farm Uitkomst, where the Upper Pyroxenite and Gabbronorite and Upper Gabbro Units are not exposed. Thus, she interpreted the Complex as an inverted fractionation sequence with the least differentiated peridotite zone at the top, the pyroxenite zone in the centre and the fractionated gabbro at the base. Sulphur isotopes of different rock units and sulphide minerals provided evidence for a sedimentary source for most of the sulphur, and thus the mineralization was interpreted to have formed due to contamination.

Strauss (1995) studied the whole rock and mineral chemistry of the Basal Gabbro on Slaaihoek 540JT, noting a similarity in geochemistry with the marginal rocks of the Muskox and Insizwa Complexes. Strauss (1995) observed a high Cu/(Cu+Ni) ratio of the Basal Gabbro and he attributed this to ore formation involving supercooling and country rock assimilation during emplacement of the Basal Gabbro.

Gauert *et al.* (1995) and Gauert (1998) carried out a comprehensive study of the Uitkomst Complex, looking at S isotopes, whole rock-and mineral chemistry of several boreholes along a strike length of 10 km. It was proposed that the Uitkomst Complex represented a magma conduit that crystallized in two stages (Fig. 2.). An early, relatively contaminated pulse of magma formed the Basal Gabbro, with the overlying Lower Pyroxenite representing a dense sulphide-rich highly contaminated cumulate rock. The bulk of the harzburgitic units are thought to have crystallized under open system conditions from magma that flowed through a magma conduit. The upper portions of the Complex crystallized to produce a normal fractionation sequence of the Upper Pyroxenite and Gabbronorite units in a closed system as a result of apparent deactivation of the conduit (Gauert *et al.*, 1995). The base of the closed system was placed about 75 m below the top of the Main Harzburgite Unit by De Waal *et al.* (2001). Gauert and co-workers did not distinguish the Upper Gabbro Unit from the Gabbronorite Unit. Based on S and Sr isotope studies of the Complex Gauert *et al.* (1995) suggested that the magmatic sulphur was contaminated by sedimentary sulphur, probably derived from the shales of the Timeball Hill Formation.

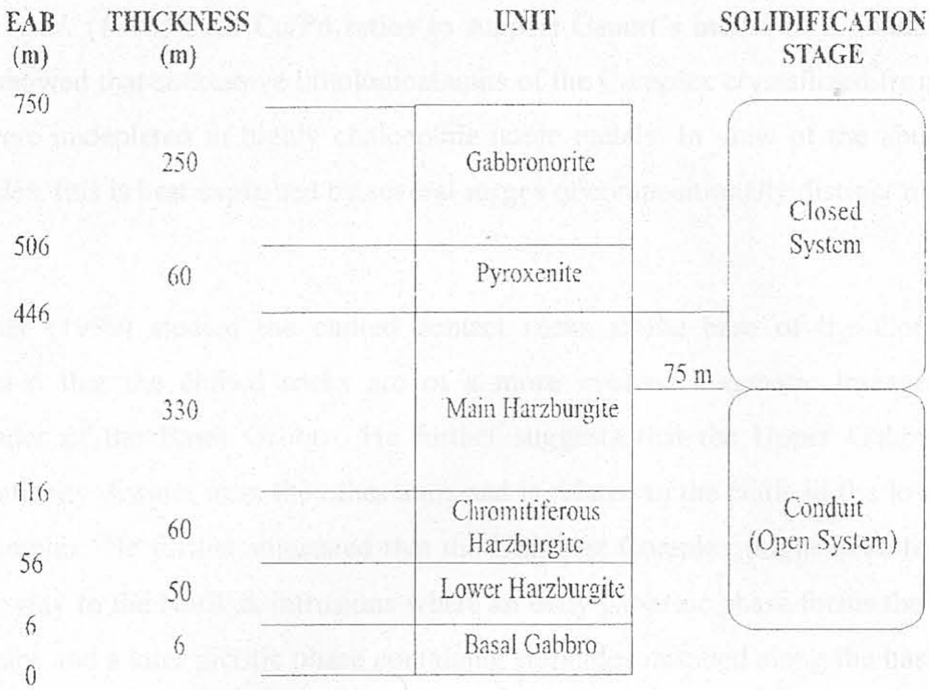

Fig.2. Lithological subdivision and solidification stages of the Uitkomst Complex (From Gauert *et al.*, 1995 and De Waal and Gauert, 1988). EAB indicates the mean elevation above the base of the intrusion and the thickness values are averaged. Vertical scale is approximate.

Gauert *et al.* (1995) and Gauert (1998) put forward three main arguments for the magma conduit model.

- The elongated tubular shape of the Complex.
- The large proportion of sulphides and chromite in relation to silicates within the basal units of the Complex, creating an apparent mass-balance problem. However, in view of the poorly known geometry of the Complex, this argument needs further constraint.
- Absence of a normal fractionation trend in the ultramafic rocks. A constant composition of the Main Harzburgite substantiates the existence of an infinite magma source. This would imply movement of large quantities of magma of constant composition through the conduit.

Maier *et al.* (1998) used Cu/Pd ratios to support Gauert's model of a conduit system. They showed that successive lithological units of the Complex crystallized from magmas that were undepleted in highly chalcophile noble metals. In view of the abundance of sulphides, this is best explained by several surges of compositionally distinct magmas.

Agranier (1999) studied the chilled contact rocks at the base of the Complex and suggested that the chilled rocks are of a more evolved magmatic lineage than the remainder of the Basal Gabbro. He further suggests that the Upper Gabbronorite is magmatically distinct from the other units and is related to the chills in the lower part of the Complex. He further suggested that the Uitkomst Complex might have formed in a similar way to the Noril'sk intrusions where an early gabbroic phase forms the top of the intrusions and a later picritic phase containing sulphides intruded along the base. Thus in the Uitkomst Complex the parental magma to the UGAB may have intruded first, forming chills around the intrusion. The Basal Gabbro magma may have intruded later, partially remelting the pre-existing chill, and created a gradual contact with it.

There have been two recent studies on the platinum group minerals of the Uitkomst Complex. Van Zyl (1996) noted four main minerals associated mainly with pyrrhotite. These are Kotulskite [Pd(Te,Bi)], Merenskyite [$(Pt,Pd)(Te,Bi)_2$], Stibiopalladinite [$(Pb,Cu)_5Sb_2$] and Sperrylite ($PtAs_2$). Theart and de Nooy (2001) studied the PGM in massive sulphides intruding the immediate floor rocks of Archaean basement gneiss. The PGM frequently occur as composite grains or aggregates and are preferentially associated with pyrrhotite (60%), pentlandite (20%), and chalcopyrite (6%). Thirteen percent of the PGM occur within silicate minerals and about 0.1% are hosted by magnetite. About 31% of the PGM are completely enclosed within the host mineral grain. Of these, about 80% (by mass) occur within pyrrhotite while 15% occur within chalcopyrite. The remaining 69% of the PGM occur along the grain boundaries between adjacent pyrrhotite grains or along boundaries between magnetite grains and surrounding pyrrhotite (Theart and de Nooy 2001). The main minerals include:

a. Merenskyite: (80% of all PGM.).

b. Michenerite: [PbBiTe] (5-10%).

c. Testibiopalladite: [PdTe(SbTeBi)] (5-10%).

d. Sperrylite: [$PtAs_2$] (5-10%).

e. Temagamite [Pd_3HgTe_3] (5-10%).

f. Gold [AuAg] (about 1%).

De Waal *et al.* (2001) conducted a $^{207}Pb/^{206}Pb$-age determination on clear zircon separates from the upper Gabbronorite Unit. This yielded an age of 2044 ± 8 Ma (concordant age) that is comparable to the $^{207}Pb/^{206}Pb$-age of Harmer and Armstrong (2000) for the Critical Zone of 2054.4 (±2.8). De Waal *et al.* (2001) also provided geochemical evidence that the parental magma of the Uitkomst Complex could be closely related to the B1 high-Mg andesite magma of the Bushveld Complex.