CHAPTER EIGHT: DISCUSSION AND CONCLUSIONS

8.1. Nomenclature

The Platreef has in the past been subdivided into three reefs based on texture and composition (Buchanan, 1979; White, 1994). However, the classification was mainly based on the high grade portions of the Platreef notably at Sandsloot, where the floor rocks consist of calcsilicate. On the farm Townlands, the three distinct reef lithologies as defined at Sandsloot are not evident. Instead, there are three packages of medium-grained feldspathic pyroxenite/gabbronorite separated by interlayers of ferruginous hornfels. If the modal and textural classification applied at Sandsloot is to be followed, it follows that on the farm Townlands, the A and the C-reefs are not developed. It is possible that at Sandsloot, the A-reef is developed because of intense interaction between the intrusive rocks and calcsilicates of the floor rocks, as indicated by the development of 'parapyroxenite'. For the above reason, I refer to the three pyroxenite/gabbronorite units separated by hornfels interlayers on the farm Townlands as the Lower, Middle and Upper Platreef layers.

8.2. Major and Trace element data

The mineral- and whole rock data including the S-isotopic data, show distinct compositional breaks between the different Platreef layers. This suggests that the Platreef layers are separated by hornfels interlayers rather than xenoliths, and that the intrusives represent distinct sill-like bodies rather than a single body. The interpretation is supported by the distinct S-isotopic signatures of the three Platreef layers.

The present data also reveal a reversed differentiation trend within the Platreef, with progressively more primitive layers being found towards the top. Orthopyroxene shows a broad increase in Cr_2O_3 with height, and a decrease in TiO_2. Clinopyroxene shows an analogous trend of Cr enrichment with height. Olivine from the Upper Platreef has Fo contents between 80-83 (averaging Fo_{81}) and those from the Middle Platreef have Fo from 78-83 (averaging Fo_{79}) confirming the pattern of more primitive rock composition with height established by the pyroxene compositions. Whole rock data also shows a broad increase with height in MgO, and decreases in TiO_2 and Al_2O_3, while incompatible element concentrations (e.g. Zr and Y) increase towards the base. Based on comparison to other intrusions where the basal rocks are relatively evolved and have elevated concentrations of incompatible trace elements (e.g. Muskox, Barnes and Francis, 1995), this may suggest enhanced contamination of the initial magma influxes. If this is indeed the case, it would indicate that the order of intrusion of the distinct Platreef sills was Lower Platreef, then Middle Platreef and lastly Upper Platreef. The reversed differentiation trend may also suggest the sequence is overturned, but this is not likely as there is no evidence of deformation on the farm Townlands.

8.3 Contamination

S-isotope data from the Platreef on the farm Townlands shows a strong crustal signature. The high $\delta^{34}S$ values indicate addition of ^{34}S-enriched crustal sulphur. This suggests that the Platreef has assimilated country rock material which is thought to be important in the formation of magmatic sulphides (e.g. Gain and Mostert, 1982; Buchanan and Rouse, 1984; Barton et al. 1986; Buchanan, 1988). The possible source of the crustal sulphur is the hornfels and calcsilicate of the Silverton Formation that forms the floor rocks to the Platreef on the farm Townlands. Contamination of the magma by country rocks is supported by elevated Zr/Y ratio relative to B1 Bushveld magma and by high K and Ca contents of the rocks relative to other Critical Zone rocks elsewhere.

I envisage that during emplacement of the Platreef magma, hornfels and calcsilicate were engulfed and these reacted with the hot magma releasing heavy sulphur as well as other incompatible elements. The released heavy sulphur would cause S-supersaturation in the magma and segregation of an immiscible sulphide melt enriched in heavy S.

8.4 Platinum-Group Elements

The present study has established good positive correlation between the individual PGE, and between the PGE and S, suggesting that the PGE are largely controlled by sulphides. This result may have important implications for the origin of the PGE mineralisation at Sandsloot, where sulphide ores are less common and the PGE appear to be largely controlled by PGM (Armitage et al., 2002). Although at this stage, it is not yet known in which mineralogical form the PGE are present in the Townlands core, I suggest that the mineralisation at both localities (Townlands and Sandsloot) originally formed in a similar manner (sulphide segregation in response to assimilation of external S), but that at Sandsloot, some of the S was lost due to interaction of the magma/rock with the floor rocks.

8.5 Sulphur Saturation and Magma Emplacement

The composition of olivine and the noble metal concentrations play a critical role in constraining the stage at which initial sulphide segregation took place and of what significance local crustal assimilation/contamination was to the ore forming process. The olivine from the Platreef is undepleted in Ni relative to Fo. Olivine from other sulphide-bearing ultramafic and mafic rocks elsewhere are commonly depleted in Ni relative to Fo (e.g. Voisey's Bay, Li and Naldrett, 1999). The Ni depletion is explained by scavenging of Ni from the magma by the sulphides prior to olivine crystallisation. Platreef sulphides are also relatively metal-rich when compared to many magmatic sulphide ores. The equilibration of Ni-rich olivines and metal-rich sulphides in the Platreef essentially implies that R-factors (mass ratio of silicate magma to sulphide melt) were very large. This is incompatible with the estimated silicate-sulphide ratio for the Platreef (1000 - 5000) and suggests that sulphides were entrained from elsewhere. The large proportion of ferromagnesian phases in the Platreef indicates that the rocks were deposited from a phenocryst-rich crystal mush, which would facilitate sulphide entrainment. This is in accord with the abundance of calcsilicate xenoliths in the present Platreef intersection, bearing in mind that calcsilicate is rare in the floor rocks at this locality.

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