THE APPLICATION OF XCT IN DETERMINING THE 3-D ENVIRONMENT OF IN-SITU PGM GRAINS AND ASSOCIATED MINERALS FROM THE BUSHVELD COMPLEX, SOUTH AFRICA

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ABSTRACT. 3-D analysis using X-Ray CT has yielded important findings with regard to the mode of mineralisation within the Bushveld Complex; this may enhance our understanding of the formation of platiniferous reefs such as the Merensky and UG2.

Platinum group mineralisation within the Merensky and UG2 reefs, Bushveld Complex is thought to be intimately associated with sulphide and oxide phases. The relationships between the platinum group minerals (PGM) and associated mineralisation have previously been studied using conventional 2-D techniques which, in this study, have been shown to be inadequate at accurately constraining the mode of PGM occurrence. The purpose of this study was to assess the validity of using high resolution X-ray computed tomography (XCT) in order to observe the characteristics of PGM and associated mineralogy in their natural state as they occur within the reef samples obtained from both the western and eastern limbs of the Bushveld Complex. PGM grain characteristics, associations and compositions were compiled using conventional scanning electron microscopy (SEM). PGM imaged using a SEM that appeared to be included within the grain boundaries of associated minerals were imaged using XCT with different results. An intimate relationship between PGM occurrence and base metal sulphides (BMS) such as pentlandite and chalcopyrite was established with many PGM occurring on the outside boundary of host sulphides. In addition, many PGM grains were found to be of significant size (100-200 microns), many times larger than previously reported with SEM analysis. Furthermore, the ability to manipulate and view 3-D volumes representative of whole rock samples down to a voxel resolution of 15 micron enabled the user to observe small scale structures, texture variations and clearly discern the mode of PGM occurrence.

Oriented studies of core samples from different locations in the Bushveld Complex allowed for the comparison of PGM environments and the variation of these characteristics in relation to stratigraphic position in the reefs. In addition, the grain shape and interconnectivity of PGM and BMS can be used to indicate directions of fluid flow during the emplacement of mineralisation. The correlation between images and compositions obtained from SEM analysis with 3-D volumes and image slice stacks from XCT was done to authenticate the validity of the results obtained from the XCT (Figure 1). This is due to the fact that during post processing of XCT data, mineral phases are identified using properties such as mineral specific gravity values and average atomic numbers, not composition. The combination of 2-D techniques such as SEM and 3-D XCT proved to be necessary in order to accurately delineate the boundaries of different mineral phases to ensure accurate thresholding of grey-scale values obtained from the XCT. The non-destructive technique of XCT yielded important findings regarding the in-situ characteristics of PGM. However, the validity of XCT data is dependent upon a sound geological knowledge of the samples being scanned. Continued use and refinement of XCT for samples of this nature will contribute to advances in the understanding of PGM deposits throughout the world.