

# Platinum-Group Element and Chalcophile Element Distribution in the Merensky Reef, Western Bushveld Complex

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The Merensky Reef of the Bushveld Complex is one of the world's largest concentrations of platinum-group elements (PGE), yet its origins are poorly understood. In the literature three types of models are proposed for the origin of the reef; a) the PGE were collected by a sulphide liquid, b) the PGE were collected by a sulphide liquid and then redistributed by late magmatic processes, c) the PGE were collected by clusters. In order to investigate these models we have determined major oxide, trace element and PGE concentrations in 24 samples taken from 2 meters of bore hole core through the reef (which at this locality consists of anorthosite, chromitite, melanorite, chromitite, melanorite) and its immediate sub-economic foot-wall and hanging wall.

We have tested the collection of PGE by sulphide liquid hypothesis by numerical modelling. The concentrations of the chalcophile elements and PGE in the silicate rocks can be modelled by this hypothesis (Figures. 1a to c). The concentrations of the chalcophile elements in the footwall rocks may be explained by modelling (Figure 1a) the rocks as containing small amounts of sulphide liquid which equilibrated with a large volume of silicate liquid (N=1000 to 5000). To model the chalcophile elements of the silicates rocks of the reef (Figure 1b) more sulphide liquid (1 to 5%) is required to have equilibrated with a very large volume of silicate liquid (N=30 000). The chalcophile element concentrations in the hanging wall rocks can be modelled by assuming that they formed from a silicate liquid that was depleted in chalcophile elements possibly by the removal of the sulphides that formed the reef (Figure 1c). The model suggests that the rocks should contain 0.5 to 2%

sulphides. For all silicate rocks, the amount of sulphides modelled and observed in thin section are in broad agreement.

For the chromite bearing rocks, however, it proved difficult to model the chalcophile element concentrations. (Figure 1d). The Pd, Au, Cu and Ni contents of the chromite bearing rocks can be modelled by the presence of 1% sulphide liquid, but the Os, Ir, Ru, Rh concentrations of the model are too low. We thus considered the redistribution model. Droplets of sulphide liquid could have been trapped between the chromite grains. During compaction and cementation of the chromitites the sulphide liquid could have crystallized monosulphide solid solution (mss) enriched in Os, Ir, Ru and Rh. The fractionated sulphide liquid would be squeezed out into the overlying magma. However, an mss cumulate would not be rich enough in Pt, Pd, Au and Cu (Figure 1d). An alternative to mss crystallization would be platinum-group minerals (PGM) crystallization. If the fS<sup>2</sup> of the sulphide liquid were low, then PGM such as laurite and isoferroplatinum could have crystallized from the sulphide liquid resulting in enrichment of Os, Ir, Ru and Pt in the sulphide cumulate of the chromitites. Thus, redistribution of the PGE during sulphide liquid crystallisation is a viable model for the formation of chromite bearing rocks.

If the cluster model is applied to the observation, then it must be argued that when the chromite crystallized from the magma it provoked the crystallization of Os-Ir-Ru-Rh-Pt clusters along with the sulphides thus enriching the chromite-rich rocks in these elements.

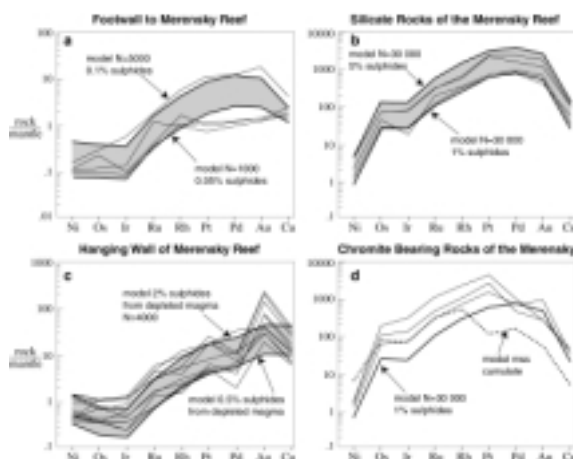


Figure 1: