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Characterization of Platinum Group Element distribution in Sulphide Ores within the Merensky Reef at Modikwa and Two Rivers Platinum Mines, Eastern Bushveld Complex South Africa

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The Critical Zone of the Bushveld Complex hosts the Merensky (MR) and Upper Group 2 (UG2) reefs that carry the world's most important platinum-group elements (PGE) reserves. Information on the reefs from the eastern limb is sparse, apparently due to the fact that platinum exploration and mining only commenced recently. The aim of this study is to understand the mineralogy and the distribution of the PGE in sulphide ores within the MR of the Upper Critical Zone of the eastern limb of the Bushveld in order to; (1) Improve our knowledge of the genetic processes that formed the mineralisation of the MR and to understand the link between PGE distribution and sulphide mineralisation; (2) Assist the current mining operation to understand the mineralogy and PGM deportment of the ores in the MR as part of their transitioning from extracting the UG2 ore to MR ore. This information can be used to predict and explain the behaviour of the ore mineralogy of the MR as this will assist in modifying the current mineral processing methods and plant design for improved recoveries.

The distribution of PGE in the MR has been characterized by determining the PGM and the concentration of PGE in the base metal sulphides (BMS), which are important carriers of PGE in the magmatic deposits. Samples from the mineralized part of the MR pyroxenite were selected from four borehole intersections, two boreholes each from Two Rivers and Modikwa Platinum Mines in the eastern Bushveld Complex. Mineral Liberation Analyser (MLA), Scanning Electron Microscopy (SEM) in conjunction with Electron microprobe (EPMA) was used to determine the compositional variation of the PGMs and the PGE elemental distribution in the base metal sulphides. Broadly, the study demonstrated that the BMS which commonly include pyrrhotite, pentlandite, and chalcopyrite are the principal sulphides with minor amounts of pyrite; however, pyrrhotite is the most dominant. Amongst the most abundant primary silicate minerals, orthopyroxene, clinopyroxene and plagioclase were identified while commonly occurring alteration silicates include talc, serpentine, magnetite and chlorite. The PGM indicated three types of association i.e. the association with BMS, the association with chromite and the association with silicates. The study also revealed that there is a strong PGM and BMS association typically, chalcopyrite. All samples in the MR from both mines examined contain a range of PGMs. The PGMs range in size from less than a micron to about 125 microns with an average of 20 microns. Most of the PGMs occur close to the chromitite stringers while some occur within the pyroxenite range. PGE distribution in the sulphides at Modikwa showed pentlandite containing the highest concentrations of palladium (up to 379 ppm) while the highest rhodium concentrations (up to 793 ppm) were contained in chalcopyrite. Samples from Two Rivers revealed pentlandite as the principal host of both palladium and rhodium, with concentrations reaching up to 695 and 930 ppm respectively. The pyrrhotite compared to other sulphides contained all the elements. The PGE grade profiles showed top loaded mineralisation at Modikwa and bottom loaded mineralisation at Two Rivers. Willmore et al. [1] reported that the PGE

were scavenged from the footwall by a fluid that subsequently reacted with the magma at the crystal magma interface to produce a primary sulphide precipitate.

Reference:

[1] Willmore et al., (2000). J Petrology. 41: 1517-1539