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Modelling the Merensky Reef variability at Lonmin's Marikana Operations

Hoffmann, D., and Wansbury, N.T.

Lonmin Mineral Resources Department, Marikana (corresponding author dennis.hoffmann@lonmin.com)

The continuity of economic platinum-rich mineralisation in the Merensky Reef of the Bushveld Complex is well known, and this has been established through the selective extraction of mineral reserves over 10's of kilometres along strike. The Lonmin Karee Mine rests within the southern limb of the western Bushveld Complex, and here the Merensky Reef occurs within the transition between the narrow pegmatoidal reef-type in the west and the thick pyroxenite reef-type in the east, and has a high degree of lithological and grade variability. The crystallisation of multiple chromitite layers (1-20 mm thick) and the apparent coalescing or removal of these chromitite layers have been interpreted by geological researchers [1] to reflect repeated emplacement and erosional processes. The occurrence of chromitite layers within a variable thickness of orthopyroxenite host have been used to define five facies types. The statistical assessment of lithological thickness and PGE concentration profiles for each facies are used to select an appropriate mineral resource cut. In some cases, it is necessary to trade-off between a fixed and variable cut thickness to necessitate improved extraction whereby higher grade over a narrower interval is taken in preference to increased content over a wider interval.

The selection of the mineral resource cut is done via the generation of grade histograms from surface borehole and underground channel samples. The vertical grade profile is often truncated using a 2 g/t cut-off which is generally found to be a natural transition of the PGE concentration. The sampled assays for the material within this selected cut is then composited to obtain a mineral resource or "channel" intersection value. Two important aspects of the mineral resource modelling process is defining the lateral boundaries between facies and dealing with mixed facies where two different mineral resource cuts are present in near equal proportions. In the former, a trade-off between content and concentration is used to define the boundary, whereas in the latter a probability approach may be more appropriate when dealing with mixed facies.

Mineral resource block models are constructed from the estimation of the parameters such as thickness, grade and accumulation using ordinary kriging of the selected composite data. These models are used for mine planning and mineral resource reporting; and are closely aligned with the operational extraction, where the selected cut may be modified to improve on the local extraction.

This study describes the processes used to obtain a robust mineral resource estimate within a complex and variable geological environment. It then continues with multiple aspects of reconciliation of the facies, grade and PGE content where the relationship between predicted and actual on local and global scales is described. The benefit of a higher grade is also then considered in context of mill recovery and financial viability.

References:

[1] Hutchinson, D, Foster, J, Prichard, H and Gilbert, S. (2015). Concentration of Particulate Platinum-Group Minerals during Magma Emplacement; a Case Study from the Merensky Reef, Bushveld Complex. Journal of Petrology, 2015, Vol. 56, No. 1, 113–159.