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Platinum group minerals in oxidised chromitite layers and their behaviour during chromite concentration: a process mineralogy approach

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Chromitite layers of the Lower Group (LG) and Middle Group (MG) in the Bushveld Igneous Complex are typically processed to produce chromite concentrates for metallurgical and chemical markets. The potential exists, however, to extract platinum group elements (PGE) as a by-product from these layers, thereby increasing resource efficiency. In this study, the mineralogical characterisation of open pit and chromite concentrator samples was conducted to assess the viability of extracting PGE from the LG and MG chromitite layers, as a by-product of chromite concentration.

Samples were collected from an open pit, where oxidised chromitite layers are being mined, as well as from the chromite concentrator at Thaba Mine, in the western Bushveld Igneous Complex. Pit samples were collected from the LG6 upwards to the MG4 layer, whilst the plant samples were collected when the MG4 chromitite layer was being processed. Mineralogical techniques employed were X-ray diffraction (XRD) and scanning electron microscopy (SEM) for modal abundance and petrographic analysis respectively. The platinum group minerals (PGM) were characterised by mineral liberation analysis (MLA).

The pit samples are deeply weathered, with such alteration silicates as chlorite, clay, talc, mica and amphibole present. Chlorite and clays are observed to replace pyroxene. Base metal sulphides were only encountered in the MG1 chromitite sample, which contains preserved pentlandite occurring interstitial to chromite. The deeply weathered samples contain PGM that also show signs of being eroded or leached, thus implying PGE mobility into surrounding gangue alteration minerals. The predominant PGM are laurite and PGE-sulphides, with minor PGE-alloys. The majority of the PGM are associated with silicates whereas laurite is mainly associated with chromite.

The MG4 chromite concentrator plant samples also show a predominance of laurite and PGE-sulphides as the main PGM species. Furthermore, PGE are mainly enriched in the finer fraction of the chromite tailings stream. The chromite concentrate contains a fair proportion of PGM still associated with silicates, and opportunity exists to remove these silicates, thus upgrading the chromite concentrate and reducing PGE loss to it. To extract PGE, the final tailings should be processed further, due to the dominant association of PGM with the silicates. Finer grinding will be required to liberate the PGM from the silicates prior to froth flotation. Given the PGM alteration observed in the oxidised ores, it is unlikely that all PGE will be recovered by standard froth flotation. In order to fully understand the behaviour of the PGM in such processing circuits, metallurgical tests will be conducted on both oxidised and pristine ores at the mine, to compare the PGM recovery potential.

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