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Influence of open circuit regrind milling on UG-2 ore composition and mineralogy at Impala's UG-2 concentrator

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Abstract

Impala Platinum Limited is the world's second largest platinum producer, producing more than 1.9 million ounces of the precious metal last year. As part of Impala's ongoing expansion programme, tonnage through their principal UG-2 processing facility, near Rustenburg, was increased by 25% in 2001.

The expansion project achieved the increased throughput target but the anticipated recovery increase was not realised. Test work as part of an optimisation project indicated that open circuit regrind milling would significantly increase the overall recovery of the plant. Subsequently, the high grade regrind mill was converted from closed circuit to open circuit configuration, during September 2003, and a 3.7% recovery increase was realised.

This paper attempts to explain the recovery increase achieved by examining and comparing metallurgical as well as mineralogical changes in mill product from before and after the open circuit conversion. Other initiatives implemented during the structured optimisation project have already been published by Martin[2] et al. [Martin, C.J., Nel, E., Raabe, H., 2004. PGM ore processing at Impala's UG-2 concentrator in Rustenburg, South Africa. In: Proceedings of 36th Annual Canadian Mineral Processors Conference, Ottawa] and will thus not be discussed any further.

Keywords: Precious metal ores; Grinding; Liberation; Ore mineralogy; Particle size

1. Introduction

1.1. UG-2 ore mineralogy and processing

Extensive mineralogical studies done by Martin et al. (2004) on the Impala UG-2 ore have characterised the mineralogical composition of the UG-2 ore processed. The ore normally contains between 20% and 30% chromite (Cr_2O_3) with the remainder being made up of aluminium silicates (primary magnesium alumino-silicates such as feldspars, pyroxenes and chlorite, and hydro-thermally altered silicates such as amphiboles and talc).

It was also shown that sulphide mineralisation is sparse compared to Merensky ores. The feed to Impala's UG-2 plant contains 0.1–0.2% sulphides; these are composed mainly of Pyrrhotite (roughly 50% of all sulphides), Pentlandite (roughly 35%) and Chalcopyrite (roughly 10%).

The mix of PGE in UG-2 constitutes about 45% platinum, 25% palladium, 10% rhodium and 15% ruthenium. UG-2 also contains minor quantities of copper and

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nickel sulphides. PGE sulphides comprise 70% of the platinum group minerals (PGM) in the UG-2 plant feed, the remainder largely being alloys of iron, lead, arsenic and antimony, or tellurides. As is typical of such ores, UG-2 platinum group mineralisation is highly complex.

From the metallurgical perspective, however, PGM speciation is a minor issue as it tends not to dictate floatability. For example, QemSCAN studies of the Impala UG-2 plant feed have shown that the composition of fast-floating PGM is similar to that of the slow floating PGM, and the unfloated PGM, indicating no clear "hierarchy" in mineral floatability. This is consistent with similar studies on the Lac des Iles circuit in Canada (Martin et al., 2003).

To a large extent the PGMs are finely disseminated, the average grain size being less than 10 μm, so that grain size, liberation and association tend to dictate mineral floatability. Platinum group mineral grain size and association can be split into four categories:

- liberated PGM,
- PGM associated with base metal and iron sulphides,
- PGM occurring on host mineral grain boundaries (mainly silicates),
- PGM locked in silicates.

Floatability of these four categories decreases from the top to bottom of the list with locked PGMs being almost impossible to float.

Processing of the UG-2 ore has always been problematic due to the high chromite content of the ore feed and even though chromite does not respond to floatation, ultra fine chromite particles will report to the floatation product largely through entrainment.

Concentrates with high chrome values present significant complications to the downstream smelting process and thus Impala limits UG-2 chrome in concentrate values to less than 3%. This is normally achieved through reducing the generation of chrome slimes through over grinding in the secondary milling step and by restricting water recovery.

1.2. Ore separation circuit

UG-2 ore has been processed through a designated plant at Impala since the early 1990s with a number of circuit changes being made through the years. Originally the ore was processed through a conventional mill–float circuit that was changed to a MF2 (mill–float–mill–float) circuit in the mid-90s. During the late 1990s the need was identified to increase UG-2 processing as the ore profile from the mine was changing to include more UG-2 and less Merensky ore.

Pilot plant test work by Hinde and Naik (1999a,b) from Mintek established a unique ore separation flow sheet that would allow for a 25% increase in mill throughput at increased PGM recovery.

The main features of the ore separation circuit as shown in Fig. 1 include:

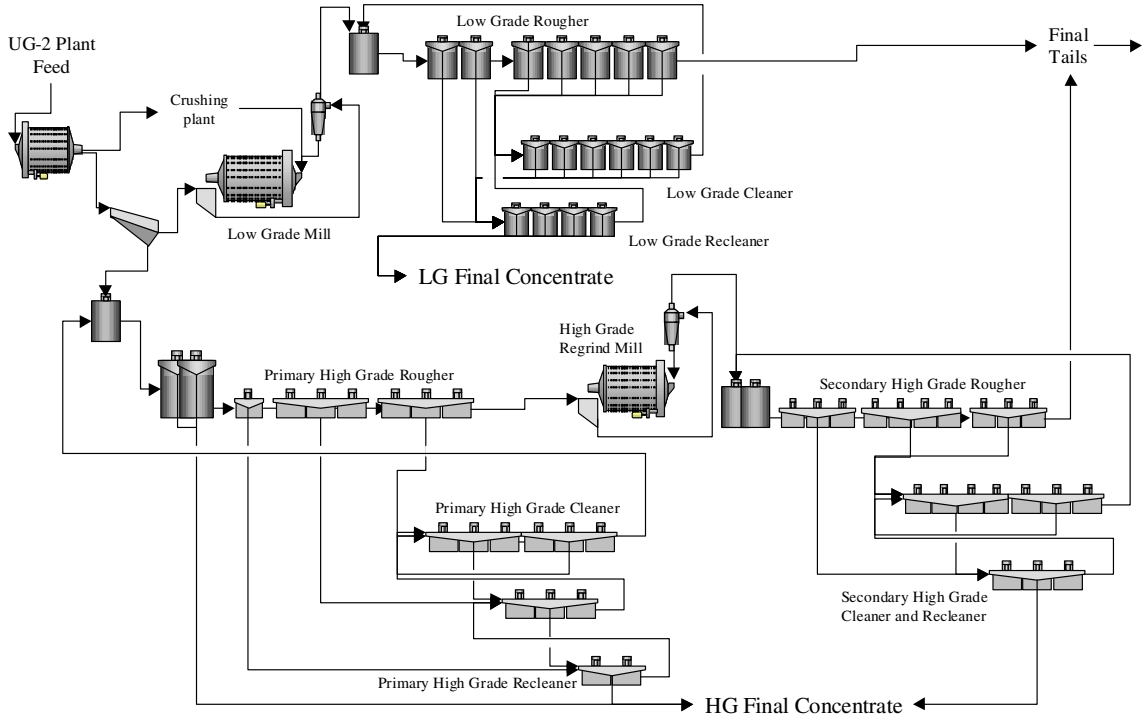

Fig. 1. Ore separation circuit.