The Role of Gravity and Intensive Cyanidation in Processing Preg-Robbing Gold Ores

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ABSTRACT

A flow sheet has been developed to treat a high tonnage highly preg-robbing gold ore. The ore is low-grade and fine grained with a high proportion of very fine free gold. The key components of the flow sheet include gravity, flotation, intensive cyanidation with direct electrowinning, and carbon-in-leach of the flotation concentrate. The circuit produces a low overall mass pull to concentrate allowing economic intensive treatment of large tonnage low-grade material. Efficient recovery of fine gravity gold using a Falcon concentrator in both the milling and flotation circuits, and subsequent intensive cyanidation in a Gekko InLine Leach Reactor is critical to the process with over 70 per cent gold recovery expected in this circuit. Grind size control was also found to be important in controlling the activity of the preg-robbers in the carbon in leach circuit and also in the solid liquid separation performance. Tests at the large-scale demonstration plant have been conducted to demonstrate the effectiveness of this flow sheet.

A large low-grade deposit is currently under development with the aim of developing a 10 Mt/a treatment plant with the subsequent addition of equivalent sized process lines in multiples of 10 Mt/a. The economic development of this orebody is critically dependant on understanding and exploiting the properties of the ore. In particular it is critical to minimise the effect of preg-robbers by recovering free gold with Falcon concentrators and inline leach reactors. Recovery of the remaining gold by flotation into a small mass yield allows this fraction of gold to be treated by CIL leaching utilising high carbon levels. It is critical is to ensure operation at the optimal grind size to maximising liberation of the free gold and minimising preg-robber activity.

The ore has been identified as preg-robbing with low recoveries obtained if treated using conventional cyanidation and carbon absorption. The mineralogy consists of predominantly fine grained free gold with minor sulfides including pyrite and arsenopyrite. With conventional cyanide leaching in the absence of carbon, gold recovery is less than 50 per cent. Direct cyanide leaching of the ore in the presence of activated carbon results in an improved but still uneconomic gold recovery.

The gravity recoverable gold content of the ore (GRG as defined by Andre La Plante) has been measured to be 70 per cent to 85 per cent in various tests with liberation grind size of approximately 106 μm. This indicates gold is predominantly free and suitable for recovery by batch centrifugal concentrators into a low mass yield. This property of the ore presents the opportunity to maximise the recovery of gold by separating it from the majority of the preg-robbers prior to leaching. Due to the very fine gold particle sizes and the necessity to maximise recovery of this fine fraction Falcon concentrators were selected for the duty, with their proven high recoveries at very fine gold sizes.

The gravity recovery in the milling circuit is designed to be in the range 55 to 65 per cent. This has been achieved in the existing pilot plant using a Falcon operating on ball mill discharge within the mill recirculating load.

Intensive leaching in an inline leach reactor is essential to recover the gold from the gravity concentrates. Tabling is not a preferred option since recovery is lower than intensive cyanidation and any gold losses to table tails will report to CIL where recovery is reduced by the presence of preg-robbers. Furthermore, tabling recovery from the gravity concentrates is particularly poor due to the fine particle size of the free gold. ILR recoveries of 98 per cent were demonstrated in the pilot plant using an ILR100BA and leach conditions were investigated in the lab using pilot plant generated Falcon concentrate. Recovery of gold from the pregnant solution was achieved with direct electrowinning at pilot and efficiency and sizing parameters were determined at lab scale.

To further increase free gold recovery Falcon concentrators will be installed in the flotation circuit. Location of the Falcons in the circuit is not finalised but installation on the rougher concentrate stream is

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favoured since it will allow multiple pass recovery. This is expected to recovery a further ten to 20 per cent of the gold, as indicated by lab tests on pilot plant generated material.

The gravity concentrate from the flotation circuit will also be leached using inline leach reactors. Initial intensive cyanidation tests carried out on lab generated flotation concentrates indicated higher recoveries than CIL can be obtained even though the concentrates contain significant levels of preg-robbing material. This can be explained by the high cyanide, high pH leaching conditions used in the ILR which alters the absorption equilibrium of the preg-robbers. Further optimisation of the leach conditions will be undertaken once more concentrate becomes available.

Recovery of the remaining gold content is achieved by flotation into a small mass yield, however the preg robbers are also recovered into this concentrate.

Due to the presence of the preg-robbers gold leaching must be carried out in the presence of high levels of activated carbon in a CIL system. The recovery has been shown to be strongly dependant on the carbon loading and the concentrate particle size. The carbon competes against the preg-robbers for dissolved gold while excessive grinding increases the surface area and activity of the preg robbers. This has been demonstrated in test work however the economic optimum leaching conditions and carbon loading have yet to be determined.

The grind size is critical to the economics of the project, not only due to its effect on gold recovery but also due to its effect on the major operating and capital costs at both the front and back end of the process. It is critical to grind enough to obtain both gravity free gold and flotation liberation at low mass yields however over-grinding results in large increases in mill size and power at the front end and filtration or thickening costs at the tails. Because these unit operations treat essentially all the plant feed even small changes can result in major impacts on project economics.

The viability of this project is greatly enhanced by the high recovery of gold into a small mass yield. In particular the production and intensive leaching of the free gold gravity concentrates will allow over 70 per cent of the gold to be recovered efficiently with minimal impact from preg-robbers. By using flotation the mass of the remaining fine preg-robber contaminated material, to be leached in CIL, is greatly reduced allowing this difficult material to be economically treated.

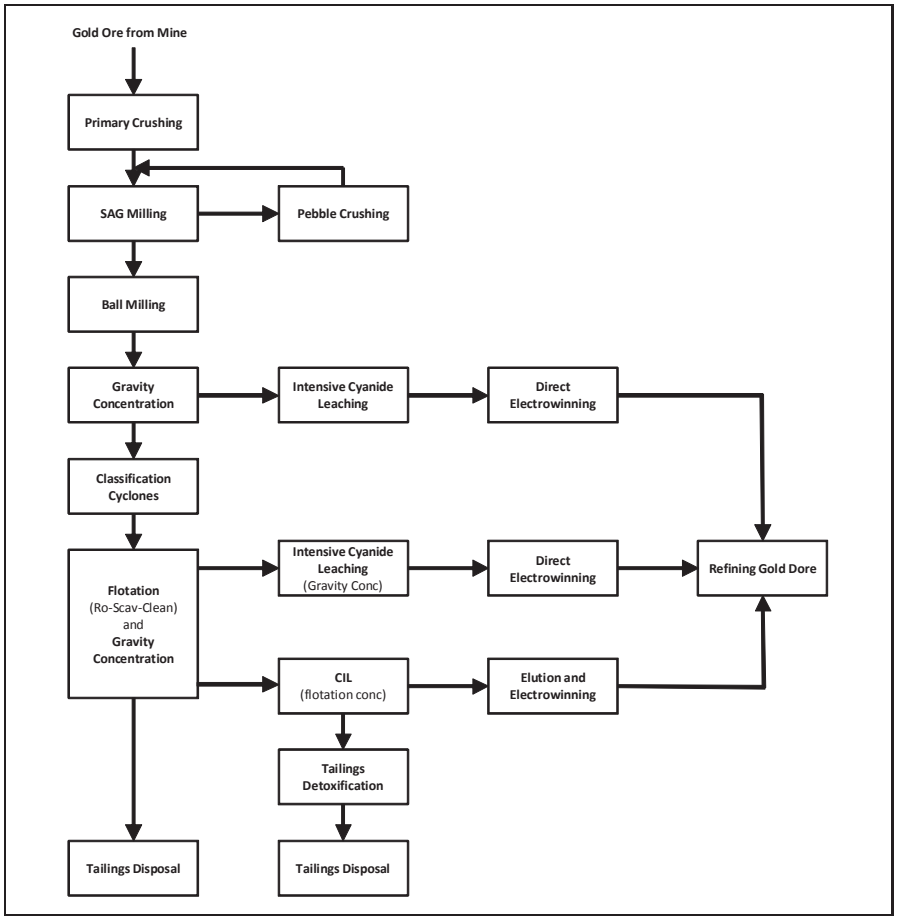

FIG 1 - Simplified gold recovery process block flow diagram.