Optimising the recovery of stopes at Bentley Mine through rockfill stabilisation and cemented aggregate fill

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ABSTRACT

The Bentley underground mine, which is located 60km north of Leonora, Western Australia, is owned and operated by Round Oak Minerals Pty Limited. A high-grade Zn-Cu Volcanogenic Massive Sulphide (VMS) orebody, Bentley was discovered in 2008 with production commencing in 2012. Long-hole open stoping is employed to mine the steeply dipping ore body, and in recent years the Avoca method has been adopted. This requires all development in a particular area of the mine to be completed prior to stoping commencing in a bottom up sequence. Voids are commonly backfilled with loose Run-of-Mine (ROM) waste loose rockfill (LRF); or alternatively cemented rockfill (CRF) can be used.

Stopes in the 3860 AOS and 3900 AOS panels were located below previously extracted Avoca zones, with LRF situated immediately above them. These high-grade stopes were originally designed with rib and sill pillars to maintain control of the existing backfill during extraction. Due to changing factors over time, including mining economics, alternative options to achieve full extraction of the stopes were reviewed, including:

- Mining small successive full height stopes which would involve drawing a blanket of LRF down with the extracted ore (stoping under waste);
- Stabilisation of the existing LRF above the stopes and implementing a primary/secondary stoping sequence, with the primary stopes backfilled using a cement fill.

An assessment of these options was undertaken which determined that the second full extraction method was the most beneficial to the operation, and could be achieved using a cement grout (Minova's FB200 grout) to stabilise the LRF in conjunction with implementing a sequence where the primary stopes would be backfilled with cemented aggregate fill (CAF).

Footwall drives were developed adjacent to the rockfilled stopes, allowing for the installation of horizontal grouting conduits, as well as providing access to the top of the planned 3860 and 3900 level stopes for the placement of CAF. An interval at the base of the previously rockfilled stopes was grouted at multiple horizons to achieve the required thickness, with a comprehensive quality assurance/quality control (QA/QC) process undertaken. Primary stopes were CAF backfilled via an arrangement of downhole winzes, linking the top of primary stopes to cross-cuts developed off the associated footwall drives. CAF was delivered underground through an open reticulation network that was extended to the specific levels.

Overall the successful implementation of the revised mining method effectively increased ore recovery while maintaining control of overbreak and dilution, providing significant financial upside. This was achieved while maintaining effective controls in light of the changes to the risk profile. Stabilisation of the existing rockfill has allowed the extraction of stopes to full height, including the originally designed sill pillars, representing an average 23% increase in ore tonnes on the initial design, with dilution from the stope crowns averaging less than 1%. The use of CAF in association with primary/secondary stoping, eliminating the need for rib

pillars, has yielded an average 47% increase in ore tonnes compared to the base case mine design.