HotShot® Induces Breakthrough In Cave Propagation

Project Summary

ELECTRONIC DETONATION AT WORK

In 2005, *Harmony Gold's Mount Marion* underground gold mine commenced stoping in the mine's western zone, using the longitudinal sub-level caving method for production. But after six months of stoping, production had not progressed as the unsupported span was too small to induce caving. Blasting with pyrotechnic detonators was not an option due to the length of the holes and the risk to the project.

Dyno Nobel, together with Harmony and 360 Drilling, developed an innovative drill and blast solution to promote cave propagation and improve safety. Taking into consideration the mine's unique features, Dyno Nobel's expertise showed how a smart design with HotShot® electronic detonators would allow the span to be increased.

Precise and flexible delay timing was critical. Initiation systems would be pushed 90 meters into holes, more than three times the usual limit, and immersed in emulsion for up to four days.

The design's execution demonstrated HotShot's robustness and precision. The blast was successful. Caving was induced, substantially increasing production in the new zone, without delays to ore recovery in other parts of the mine.

Background

PRECISELY CONTROLLED FIRING HELPS DELIVER ADDITIONAL ORE

Harmony Gold Australia's South Kal Mines owns the Mount Marion Mine, which is located 55km southwest of Kalgoorlie in Western Australia. Production is approximately 45,000 tonnes of ore per month at an average grade of 4.4 grams per tonne. Operations are divided into east and west zones.

Stoping in the mine's western zone began in November 2005. The time frame for steady caving to commence was uncertain and, until caving commenced, less than half the ore fired was being recovered. Dyno Nobel's innovative solution – enabled by the much greater flexibility, accuracy and communication capability of electronic detonators - was to fire out a section of the Western Zone's hanging-wall to increase the unsupported span. Site management evaluations showed that payback was possible even if caving did not begin immediately, as controlled firing would allow additional ore to be mined.

Project Goals

IMPROVED RECOVERY THROUGH DYNO NOBEL'S BLAST DESIGN

The key objective was to improve recovery from the mine's western zone by propagating the cave. This had to be carried out within the constraints of a producing gold mine, which was located immediately above the current stoping operations.

An advantage of Dyno Nobel's blast design was that minimal development was needed, helping to ensure low costs. As drilling vertical holes was potentially risky and would delay stope production, the decision was taken to use shallow angled drill holes, up to 90 meters long, to hold the explosives. This was the maximum length allowing effective removal of drill cuttings.

Dyno Nobel's design minimized the number of connections in the hole, and at the collar, while providing redundancy. However, connectors had to withstand being dragged along the length of the holes and being covered in emulsion for up to four days. Two detonator trains were used in a direct 'toe to collar' in-the hole firing sequence, with safety primers spaced 10 meters apart.

DYNO
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Groundbreaking Performance

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The preferred solution was to fire all holes in a single blast, as staged detonation could risk damaging holes and prevent the charging of later blastholes.

Technology Applied

HOTSHOT AND TITAN® 7000 – ROBUST AND CAPABLE

Performance of Dyno Nobel's gas sensitized TITAN 7000 emulsion was confirmed using a 165mm diameter, 12-metre test hole drilled at 35 degrees above horizontal. This was loaded with gassed emulsion, but not primed, and after two weeks the emulsion was still intact with no slumping. A special 100-metre hose was manufactured for the bulk emulsion delivery vehicle.

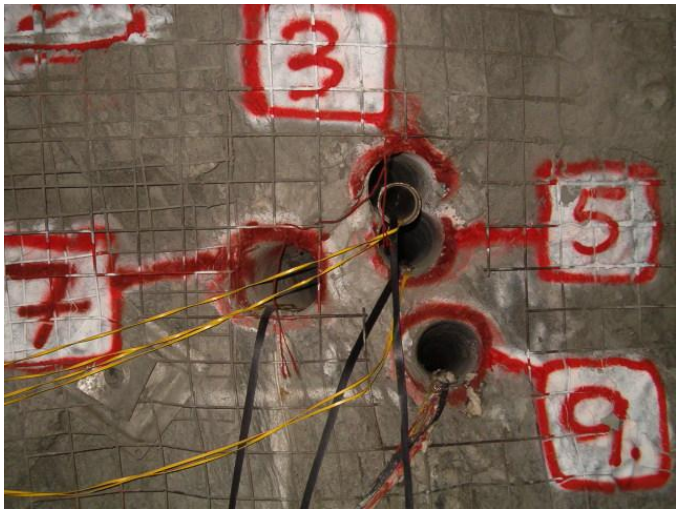
Results demonstrated HotShot's robustness and TITAN 7000 emulsion's strong adherence capabilities. The successful blast used over 7 tonnes of TITAN 7000 emulsion and 46 detonators. Over four days of charging there was no emulsion slumping. HotShot allowed the charged holes to be retested every morning, confirming the integrity of the detonator trains.

The HotShot electronic detonator system performed extremely well. Despite dragging connectors and leads up to 90 meters in the hole and having up to 12 connectors immersed in emulsion for up to four days, there were no communication errors or leakage.

Value Added

REDUCED PRODUCTION COSTS AND INCREASED ORE RECOVERY

The results were excellent. Electronic detonation successfully induced caving. An immediate increase of seismic activity after the blast indicated that caving of the Mount Marion Mine's Western Zone had commenced.



Dyno Nobel's innovative solution helped to reduce production costs and extend the economic life of the mine. Efficient design controlled vibration and debris, enabling drill and blast activities to be carried out with minimal change to mining operations. Benefits included reduced potential of air-blast and lower risk of possible delays to production in other parts of the mine.

Using electronic detonation substantially increased ore recovery, with production rates returning to levels not seen for over two years.

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