Case Study

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Microseismic analysis to identify the caving front associated with cave mining operations in New South Wales

A microseismic system was implemented at a block caving operation at Ridgeway gold mine in eastern Australia. Compared with geomechanical methods, the microseismic system reliably tracked the position of the caving front during ore extraction.

Fig. 1: Cave front at the Ridgeway mine eventually broke through to the surface.

Operated by Newcrest Mining Ltd., the Ridgeway gold mine uses a block-caving method to extract a gold-copper deposit in central New South Wales, Australia. An ESG microseismic system was implemented to compliment existing geomechanical monitoring tools, to study the ability of microseismic analysis to characterize the cave front over time.

Background

Cave mining is typically performed at sites where a large ore deposit is located so far beneath the ground surface, that open-pit extraction is not economically or environmentally feasible. Block caving is an underground mining method that approaches the ore body from beneath the deposit. As material

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is removed, the ore body is allowed to collapse in a controlled manner due to gravity. Continual extraction of the broken ore fragments for processing causes the cave front to propagate upwards, until either all of the ore is removed or, the cave front breaks through the surface.

Challenge

Continual monitoring of the caving front is important for mine management. Commonly used geotechnical methods for tracking the cave front include plumbing, camera surveys and extensiometer readings made from boreholes at the ground surface. However, these methods provide information at discrete moments at the time of measurement and therefore may be limited in space and time.

Microseismic monitoring of mining operations is widely acknowledged for its ability to provide continual, 3D-coverage of mine seismicity for real-time assessment. Incorporating a microseismic monitoring system with existing geomechanical tools will therefore enable a detailed analysis of how microseismicity can be used to track the caving front during ore extraction.

ESG Solution

An ESG microseismic system was implemented at the Ridgeway mine in eastern Australia. An array of eleven triaxial accelerometers was established in 4 vertical boreholes throughout the site, maximizing coverage at depths ranging from 90 to 500 meters. A series of small blasts with known locations were used to calibrate the system. Highly accurate seismic event locations were determined using P- and S-wave first arrival times.

Fig. 2: Position of the cave based on borehole measurements compared to location of seismic events in fractured zone of the cave front.

Over a period of 10 months, the cave front migrated upwards and eventually reached the surface. When compared to direct borehole measurements, the microseismic analysis of event distribution and source mechanism evaluations successfully identified the position of the fractured cave front with an average location error of only 2-4 meters. Additional microseismic analysis identified the main failure mechanisms and also provided insight into the manner that microseismicity of caving is affected by the material properties of the differing geological zones of the site.

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