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Regional pillar monitoring at South Deep gold mine, South Africa

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Abstract

Regional pillars are designed to manage seismic energy emissions as well as combating rock falls and rock-bursts in deep level tabular stopes where extraction takes place over a large area. These emissions are as a result of high abutment stresses and high closure rates which in turn increase the Energy Release Rate (ERR) that occurs at depth exceeding 2000 m below surface. Generally, regional pillars in narrow tabular stopes are very squat (high width to height ratio) and therefore characteristically stable. However, the regional pillars in massive ore bodies will become more slender during the subsequent extraction and this could eventually increase the possibility of becoming unstable. The complexity and uncertainty of rock as a medium makes pre-determination of rock mass response difficult. The manner in which regional pillars in deep level massive mining react to imposed loads and their failure mechanisms is also still largely unknown.

As such, South Deep gold mine has implemented a monitoring system to assess deformation and associated velocities during ground motion resulting from pillar forming and massive mining. The system monitors and identifies hazardous areas in the mine, and based on seismic history, prediction of rock-bursts, reasonable prediction of the location and magnitude of events is possible in future. Regional pillars, which are of paramount importance during massive mining, are likely to become highly stressed as mining progresses, resulting in an increased number of seismic events in the future.

The case study done for South Deep gold mine showed an observed general increase in the number of high magnitude events per month indicating that the regional pillar may be becoming

unstable. These seismic events cannot be accurately modeled using Map 3D due to the limitations of the software (assumes the rockmass to be isotropic, homogeneous and elastic). There is therefore need to introduce an inelastic modelling software which incorporate geological structures, to represent the actual rock mass performance in order to evaluate instability.

Preliminary inelastic modelling was carried out using Phase 2 to address the shortcomings of elastic Map 3D modelling. Increasing the mining rate increased rock mass deformations and the occurrence of high magnitude seismic events probably due to accelerated slip occurring along geological structures or fracturing of the rock. Additionally, strain meter readings from the mine showed increases in stress changes both tension and in compression. The onset of pillar stability was explained to be associated with the change in the general trends of the seismic and strain data graphs from linear to exponential. The average pillar stress was discovered to be less than 2.5 times the Uni-axial Compressive Strength (UCS) of the footwall but greater than that of the hangingwall material, hence the pillar is likely to punch into the hangingwall.

The analysis of data collected during the course of the project concluded that monitoring needs to be continued, data analysed and numerical models updated regularly especially incorporating geological discontinuities to establish the onset of instability timeously so that an informed decision can be made.