Near Surface Geophysics

Integration of in-mine seismic and GPR surveys to gain advanced knowledge of Bushveld Complex orebodies

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Abstract

Improving the exploration of deep-seated mineral deposits and assessing the stability of the mine pillars require that geophysical techniques are deployed in a fast and cost-effective manner with minimal environmental impact. This research presents results from in-mine reflection seismic experiments and a ground penetrating radar (GPR) survey conducted at the Maseve platinum mine, South Africa. The research aims to develop and implement methods to image platinum group metal (PGM) deposits and geological structures near mine tunnels and assess the stability of pillars. The seismic experiments were conducted using a sledgehammer source (10 lb), conventional cabled geophones (14 Hz), and a landstreamer with 4.5 Hz vertical component geophones. The GPR survey was conducted using a Noggin 500 GPR system with 500 MHz centre frequency. An image of the underlying orebody and geological structures down to 100 m from the mine tunnel floor (~500 m below ground surface) was produced. We correlated the coherent reflections beneath the tunnel floor with a known Upper Group (UG2) PGM orebody. The final seismic section shows that the UG2 mineralisation is dissected by near-vertical dykes, faults and fractures. These structures, faults in particular, are interpreted to have been active post-mineralisation, implying that they may have contributed to the current complex geometry of the deposit. Four GPR profiles were collected around a stability pillar adjacent to the seismic lines. The radargram sections were processed to improve the signal-to-noise ratio (S/N). The results show different patterns of fracturing and stress-induced structures. These fractures were shown to be sub-vertical and, possibly, constitute complex micro-structures within the pillar, which could compromise the pillar stability and integrity. The study demonstrates that in-mine seismic and GPR surveys can be cost-effective and valuable for mineral exploration.