

Combined Underground Geophysical Investigation of Anomalous Near-mine Geohazard using Ground Penetrating Radar, Seismic, and Electromagnetics

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Abstract

Potash mining in Saskatchewan, Canada, relies extensively upon geophysical methods to map, constrain, and quantify the location, volume, and magnitude of geohazards near mining operations. In-flows are the primary risk geohazards pose. The introduction of undersaturated brine from nearby strata into mine workings can cause serious damage to the structure and longevity of a potash mine. One of the most well-developed tools for this type of investigation is 3D exploration seismic. While surface seismic performs this function well, there are a pair of shortcomings to the method. One, the resolution from surface to the mining horizon at around 1,000 meters depth is unable to map small or subtle geohazards. Two, while effective at mapping significant geohazards, seismic can struggle with characterizing anomalous features as wet or dry, thick or thin, etc.

This presentation will review a special case-study encountered at one of Nutrien's potash mines. After applying modern seismic data processing techniques to an old dataset, additional small-scale potential geohazards were identified as "heterogenous amplitude anomalies". One of these amplitude anomalies was mapped in the strata above mine workings that subsequently were made available for in-mine geophysical survey teams. Several underground geophysical techniques were deployed to characterize this anomaly: Ground Penetrating Radar (GPR); upward-looking reflection seismic; Frequency-Domain Electromagnetics (FDEM); and Transient Electromagnetics (TEM). The electromagnetic surveys were conducted twice over a period of 6 months to measure any time-lapse features over the area of the anomaly. The in-mine geophysical investigations found minimal structural features, indicating no prior weakening above the mining horizon. The electromagnetic surveys detected a resistive signature to the anomaly. This indicates an increase in crystalline salt present in the anomaly compared with surrounding geology. These results assisted the mine with de-risking the area. Two potential geological solutions are proposed to explain the lithological nature of this anomaly along with evidence for both from the acquired in-mine geophysical datasets.