Rapid Characterization of Emerging Geological Anomalies in Potash Mining using Ground Penetrating Radar and Electromagnetics
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Saskatchewan, Canada, is host to one of the largest, actively mined potash deposits in the world. Most Saskatchewan potash mines are conventional, underground room-and-pillar style. The potash deposits in Saskatchewan are sedimentary, flat-lying, and – largely – undisturbed allowing for some of the lowest cost and highest production of potash globally. 3-D surface seismic has been an excellent geophysical tool to assess the extent and continuity of the Prairie Evaporite Formation that hosts the potash deposits. 3-D seismic has also been used to map and characterize mining geohazards. Of the different types of geohazards in potash mining, salt-collapse structures are a well-known risk to operations. These structures extend from the Prairie Evaporite into the overlying stratigraphy, sometimes hundreds of meters in scale. They are a concern because of the significant inflow potential that can develop when the collapse acts as a conduit connecting the mining rooms to overlying, prolific aquifers. These large structures can be avoided well in advance during the mine-planning stage as 3-D seismic maps these features very accurately. However, smaller structures are difficult to detect, and occasionally mining operations have intersected such features. Irrespective of the size, geohazards are always assessed when encountered. Therefore, effective geophysical characterization of geological anomalies in potash mining is a critical task for effectively mitigating these hazards. This case study shows that by utilizing a combination of surface 3-D seismic and in-mine geophysical methods, such as Ground Penetrating Radar (GPR) and Electromagnetics (EM), a complex geological anomaly was characterized through an iterative process of mining and surveying. Integral to this effort was strong and rapid interdisciplinary collaboration among geoscientists, engineers, and mine planners to assess and map the anomalous area. This study was unique and challenging for several reasons. One, the geological anomaly was encountered suddenly and unexpectedly. Two, the primary indicators of the presence of the geohazard were structural features visible in the mine rooms themselves. This necessitated the deployment of various geophysical instruments to classify the anomaly. The GPR and EM data collected in the room painted a picture of the anomaly as a dry, small-scale collapse feature, later confirmed through mining. The results underscore the need for open avenues of communication across disciplines and adaptive strategies to manage risks associated with mining in complex geological settings. Additionally, the study emphasizes the value of integrating multiple geophysical techniques to provide a comprehensive and more informed understanding of geological features.