geoconvention
Calgary • Canada • May 15-17 2023

Operationally focused Geophysics in Extraction Industries: An Exciting Career

Craig Funk, Victor Okonkwo, Todd LeBlanc and Tanner Soroka,

Nutrien Ltd.

Since potash mining and extraction started in Saskatchewan some 60 years ago, geophysicists have played an important role in supporting the operations. Potash is a water-soluble potassium bearing mineral and Saskatchewan hosts about half of the world's known potash reserves. Potash is now considered a critical mineral which puts further pressure on safely operating and maintaining the potash operations. There are significant hazards that potash producers face, and without operationally focused geophysics it is unlikely that the industry would have enjoyed such success.

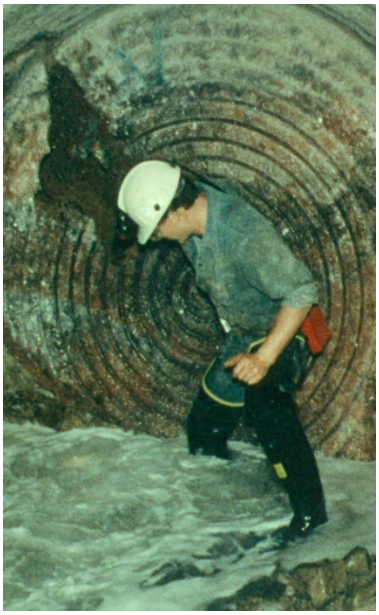

Figure 1: Water Inflow at a Saskatchewan potash mine (1984). 3D seismic was in its infancy at the time and was not used as an exploration tool until the late 80's.

Water inflows are a mine-threatening hazard to potash mines, as shown in Figure 1. In Saskatchewan, inflow risk is managed with timely acquisition of 3D seismic. Ideally the seismic is acquired 10 or more years ahead of mining into new areas. This gives time for the operations teams to adequately plan for and allocate resources for mining in the area. The cost of the 3D seismic is insignificant when compared to the capitalization cost of the operations (billions of dollars); which could either be lost due to inflows in the worst case or incur elevated operating costs from mining around previously unknown high-risk anomalies. The most significant kind of geological hazard for inflow risk are salt collapse anomalies (i.e. chimney-like cave-ins created by salt dissolution) and we show that these features are readily identified in seismic.

Another hazard which is more challenging to map with 3D seismic is the integrity of the cap-rock over our mining horizon. The Dawson Bay formation is a limestone that directly overlies the Prairie Evaporite and acts as a seal to prevent the downward migration of undersaturated brines into the mined-out rooms after mining is completed. Enhanced porosity, extensive vertical fracturing, or a combination of these features reduces the integrity of the Dawson Bay and poses a significant inflow risk should mining cause damage to it. These phenomena can't always be mapped with seismic due to resolution limits, so we turn to other geophysical methods to help us. We have successfully used time-domain EM, collected in exploratory mine rooms at 1000m depth, to detect the presence of undersaturated brine in the pore space of the Dawson Bay.

Ground Penetrating Radar (GPR) has been used in potash mines by geophysicists for some 40 years now. GPR is a particularly well-suited tool for early identification of geological conditions that could lead to unplanned falls of ground in Saskatchewan potash mines. This is a significant hazard for employees working at the active mining faces, and for 20 years the potash industry tested various configurations that would enable real-time collection of GPR data while mining was occurring. In 2013, a system was successfully tested (Figure 2) and by 2015 these systems were installed across all Nutrien's production boring fleet in the Saskatoon area. There are now 32 production borers equipped with GPR safely producing over 22 million tonnes of ore per year. Both successful and challenging cases will be briefly discussed, along with a brief overview of improvements being made to address some common interpretation challenges.

Figure 2: A prototype GPR unit being tested on a potash production boring machine at the Nutrien Cory potash mine. The GPR antenna is housed inside the box being held up against the roof by the retractable arm unit.