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How Geophysics Became Integral to Potash Mining in Saskatchewan

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Last year we celebrated 60 years of successful potash mining in Saskatchewan; a province which hosts about half of the world's known potash reserves. Besides the enormity of these deposits, they are relatively flat lying and undisturbed, which makes for some of the lowest cost potash mining operations in the world. Yet there are significant hazards that potash producers face, and without geophysics it is unlikely that the industry would have enjoyed such success.

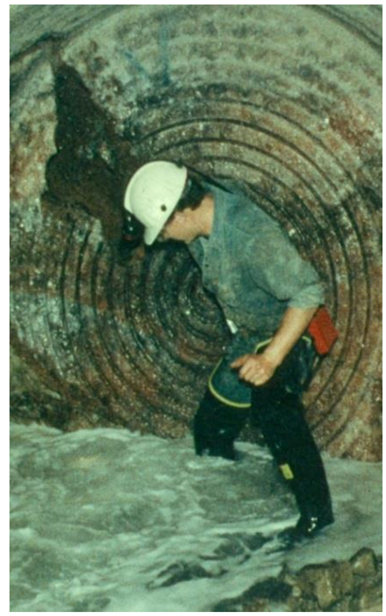
Figure 1: Water Inflow at a Saskatchewan potash mine (1984). 3D seismic was in its infancy at the time and was not used as an exploration tool until the late 80's.

Water inflows are a mine-threatening hazard to potash mines, as shown in Figure 1. Germany, for example, has about 150 years of potash mining history and over that time 46.5% of their 255 mines were lost to flooding. In Saskatchewan, we manage inflow risk with 3D seismic by providing timely identification of mine-threatening geological hazards prior to mine development into new areas. 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 an uncontrollable flood, or incurring elevated operating costs to manage an inflow. 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 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, 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.

Finally, microseismic monitoring plays a key role in the routine evaluation of rock mass response to mining in Saskatchewan potash mines. In this paper we present an unusual application where we used a simple microseismic system installed at mining level to locate blasts, Figure 2, occurring in an off-set shaft sinking operation during an expansion project at our Rocanville mine. The blasts located by the microseismic system were used to reduce the underground survey error and helped ensure that the shaft was intersected optimally by new mine workings once the shaft had reached mine level. By doing this, it allowed for simultaneous development of the shaft infrastructure at mine level with shaft sinking from surface, and is estimated to have saved the company almost $800MM by bringing the mine expansion into production two years early.

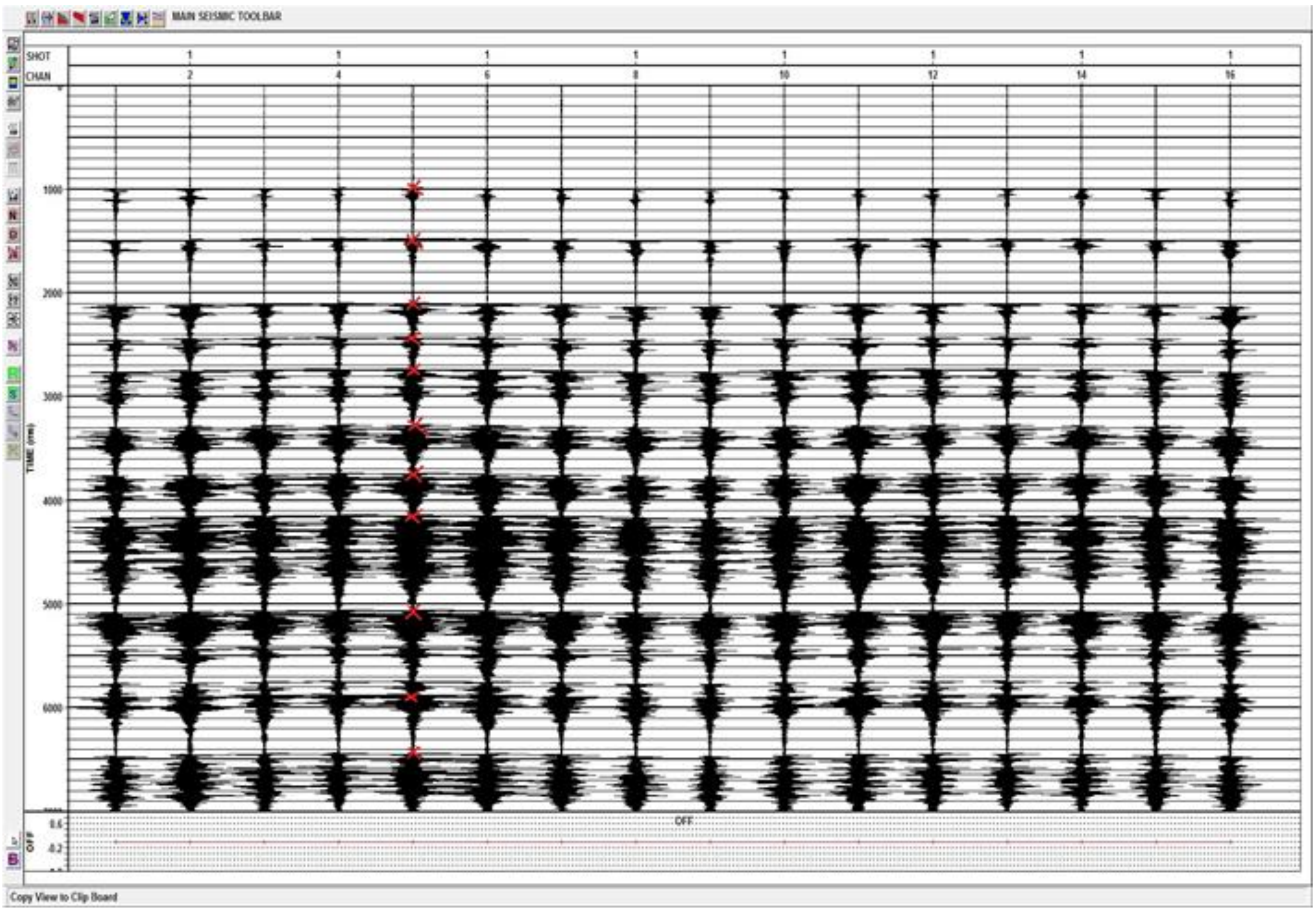

Figure 2: Shaft sinking blast sequence recorded by underground microseismic system. Data was used to locate center of shaft relative to underground mine workings. A total of 11 records were analyzed to improve accuracy of the shaft center estimate.