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3D geological to geophysical modelling and seismic wave propagation simulation: a case study from the Lalor Lake VMS (Volcanogenic Massive Sulphides) mining camp

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The global demand for base metals, uranium and precious metals has been pushing mineral explorations at greater depth. Seismic techniques and surveys have become essential in finding and extracting mineral rich ore bodies, especially for deep VMS mining camps. Geophysical parameters collected from borehole logs and laboratory measurements of core samples provide preliminary information about the nature and type of subsurface lithologic units. Alteration halos formed during the hydrothermal alteration process contain ore bodies, which are of primary interests among geologists and mining industries. It is known that the alteration halos are easier to detect than the ore bodies itself. Many 3D geological models are merely projection of 2D surface geology based on outcrop inspections and geochemical analysis of a small number of core samples collected from the area. Since a large scale 3D multicomponent seismic survey can be prohibitively expensive, performance analysis of such geological models can be helpful in reducing exploration costs.

In this abstract, we discussed challenges and constraints encountered in geophysical modelling of ore bodies and surrounding geologic structures from the available coarse 3D geological models of the Lalor Lake mining camp, located in northern Manitoba, Canada. Ore bodies in the Lalor lake VMS camp are rich in gold, zinc, lead and copper, and have an approximate weight of 27 Mt. For better understanding of physical parameters of these known ore bodies and potentially unknown ones at greater depth, we constructed a fine resolution 3D seismic model with dimensions: 2000 m (width), 2000 m (height), and 1500 m (vertical depth). Seismic properties (P-wave, S-wave velocities, and density) were assigned based on a previous rock properties study of the same mining camp. 3D finite-difference elastic wave propagation simulation was performed in the model using appropriate parameters. The generated synthetic 3D seismic data was then compared to the 3D multicomponent field survey data. Main features of the geological models, especially boundaries of main ore bodies were comparable in both data sets. This shows that the 3D geophysical model based on local geology and limited core samples is in fair agreement with the lithologic units confirmed from the field seismic survey data.