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Elastic finite-difference modeling of volcanic-hosted massive sulphide deposits, Halfmile Lake, New Brunswick, Canada

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We present elastic finite-difference modeling results over a geologically realistic 2D representation of the Halfmile Lake volcanic-hosted massive sulphide deposit, New Brunswick, Canada. The model is constrained by geological information from surface mapping and boreholes whereas petrophysical properties are provided by wireline logging data acquired in two boreholes intersecting different parts of the deposit. We analyzed the P-P, P-S, S-P, and S-S responses of the Lower and Deep mineralized zones and assessed some compositional effects by substituting massive sulphides with gabbro properties in the model. Finite-difference modeling results predict complex scattering signature associated with the Lower and Deep sulphide zones. Both zones scattered back P-P, P-S, S-P, and S-S waves generally having strongest amplitudes in the stratigraphy down-dip direction. The P-S, S-P, and S-S scattered waves, if properly recorded on multi-component data, represent useful signal that could help the targeting of deep massive sulphide mineralization. Finite-difference simulations further reveal phase-reversals on P-P wavefields scattered at the Lower and Deep zones. The phase reversals are not observed for gabbro inclusions, suggesting that this signature could be used to discriminate gabbro units from sulphide mineralization. The FD simulation successfully reproduces many events observed on VSP data from Halfmile Lake. In particular, P-S and S-S events on the radial component and P-P and S-P events on the vertical component are reproduced accurately. These positive results further indicate that multi-component surveys are required to fully understand the main acquisition, processing and imaging challenges associated with non-conventional wavemodes and their real benefits for mineral exploration.