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Seismic response of ore deposits in Kevitsa and Outokumpu mining areas: new insights from data mining and seismic forward modeling

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The Kevitsa Ni-Cu-PGE disseminated sulfide deposit is hosted by the Kevitsa mafic to ultramafic intrusion located within the Central Lapland Greenstone Belt in northern Finland. The Outokumpu semi-massive to massive polymetallic (Cu-Co-Zn-Ni-Ag-Au) sulfide deposits are hosted by ophiolite-derived altered ultramafic rocks within the Raahe-Ladoga Belt in eastern Finland. Extensive, excellent quality 2D reflection seismic data have been collected at both sites in the 2000s. In addition, there is a 3D seismic data set available from Kevitsa. The ore deposits of Kevitsa and Outokumpu have different mineralization styles, grades and scales and thus have different kinds of seismic responses as well. Imaging disseminated ore deposits with the reflection seismic method is complicated, as, for example, the Kevitsa disseminated ore itself does not have dimensions detectable with the method. However, it has been suggested that subtle localised magmatic layering within the Kevitsa intrusion controls the sub-horizontal layering and spatial extent of the disseminated sulfides, and that this magmatic layering is detectable with the reflection seismic method. Initial results from data mining via SOM (Self-Organizing Maps) analysis and seismic forward modeling of the magmatic layering within the Kevitsa intrusion are used to test these hypotheses. In the case of Outokumpu-type deposits seismic forward modeling results confirm that the semi-massive to massive ore could potentially be seen directly in the seismic data, if the deposits meet the size, thickness, and presentation constraints required for reflection or diffraction.