Seismic modeling of ore bodies – massive sulphides

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Owing to their high density compared with crystalline rocks, massive sulphide ore bodies should be excellent seismic reflectors. In contrast, attempts to image these ore bodies with reflection seismic have had limited success. One reason for this failure is that bodies are small compared with the seismic wavelengths used in conventional surveys. This leads to less than a full amplitude response being recorded. Also, if the relief on the surface of the ore body is variable, the reflection amplitudes will be attenuated. The resulting seismic response will thus consist of a complicated diffraction pattern dominated by side swipe in 2D surveys. These issues show that one is dealing with unusual data that require special processing to get a good seismic image.

We conducted 3D physical and 2D numerical seismic modelling experiments to study the seismic signature of ore bodies of complex geometry contained in a constant velocity fluid medium. The physical modelling is purely geometric and intended only to observe amplitude patterns but no amplitude analysis is envisaged. These experiments are aimed to identify the characteristic seismic expression of the ore bodies in as far as the geometry is concerned. This will help to determine the appropriate acquisition and processing parameters required to successfully image massive sulphides and similar deposits. The modelling experiments are scaled such that they mimic high-resolution 3D surveys. Records of 3,000 ms TWT, sampled at 1 ms, with a spectral bandwidth of 20-100 Hz were collected for two surveys covering an area of 900 x 300 m, with 54 000 traces each. The target was a 75 x 37.5 m doughnut-shaped ore body with a variable surface relief. The ore body was at different depths for each recording.

We find that because the signal consists of diffractions with a moveout of the background velocity, which are hence parallel to the first breaks, it becomes essentially impossible to separate this signal from the latter when the ore body is shallow. A simple analogy with the real world shows that this commonly occurs, not because the ore body is shallow, but because the background velocity is high.