Broadband seismic acquisition and processing of iron-oxide deposits in Blötberget, Sweden

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The transition towards green technologies and decarbonization has rekindled interest in reopening previously economically unviable mines to meet the growing demand for raw materials. This is the case for iron-oxide deposits in the Blötberget mining area of Bergslagen mineral district in central Sweden. The mining activity in Blötberget stopped in 1979 (Nordic Iron Ore, 2011). However, the renewed interest in recent years has led to a series of studies aiming at delineating the geometry and extent of the deposits at depth for optimized mine planning and resource estimations.

The ore in Blötberget primarily comprises high-quality iron-oxides in the form of magnetite and hematite, enriched with apatite. These deposits occur in sheet-like horizons with a moderate eastward dip along an NNE-trending zone (Nordic Iron Ore, 2011). The sheet-like mineralized horizons, ranging from 10-50 meters in thickness, are inclined towards the southwest with a dip of approximately 45° until 500 m depth, beyond which the dip becomes gentler. As of current knowledge, the mineralization is expected to extend down to 1200 m depth, where a cross-cutting reflection disrupts its continuity (Malehmir et al., 2021).

In June 2022, a novel seismic survey was conducted in Blötberget to assess the capability of combining both broadband source and receivers. The data acquisition was conducted above a well-known mineralization horizon. The survey incorporated a combination of collocated MEMs (micro-electromechanical sensors), 3-component geophones, surface and borehole distributed acoustic sensing (DAS), alongside a broadband seismic vibrator (2-200 Hz).

Expanding the bandwidth of recorded data offers several advantages, such as mitigating wavelet side-lobes, reducing sensitivity to scattering and attenuation through lower frequencies, and achieving sharper wavelets through higher frequencies. Broadband data thereby improve resolution and also depth penetration (Ten Kroode et al., 2013).

Leveraging insights from previous seismic studies in Blötberget, the high-fold broadband data facilitates improved imaging of known deposits compared to prior investigations, along with the detection of potential additional resources beneath the mineralization. However, the most significant enhancement lies in the broadband data's capacity to resolve the cross-cutting fault system, delineating the depth extent of the mineralization. This case study underscores the potential of broadband data for achieving high-resolution subsurface imaging in hardrock environments and its role in fostering a more efficient approach to mineral resource assessment in the context of our rapidly evolving era of green technologies and decarbonization.

References

Malehmir, A., Markovic, M., Marsden, P., Gil, A., Buske, S., Sito, L., et al., 2021: Sparse 3D reflection seismic survey for deep-targeting iron oxide deposits and their host rocks, Ludvika Mines, Sweden. *Solid Earth 12*, 483–502.

Nordic Iron Ore, 2011: Ludvika mines preliminary economic assessment. *Final Report. Rev 3. Ludvika Mines*, pp. 1–74.

Ten Kroode, F., Bergler, S., Corsten, C., de Maag, J. W., Strijbos, F., & Tijhof, H., 2013: Broadband seismic data—The importance of low frequencies. *Geophysics, 78(2),* WA3-WA14.