



## Innovating surface and in-mine seismic exploration solutions

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Mineral exploration industry needs to push its technological advancement towards finding the so-called critical raw materials. These materials are fundamental for our green technologies and help accelerate the energy transition towards decarbonisation. While in-mine and near-mine exploration will be more convenient in the short term, providing fresh raw materials and mines in greenfield or brownfield areas must not be forgotten in the longer term. As the chase for mineral deposits becomes deeper, seismic methods play a greater role for exploring at depth. Through a series of experiments conducted within the EU-funded Smart Exploration project, we have innovated a number of hardware and methodological solutions for in-mine as well as brownfield seismic exploration. Along with these, legacy data have also been recovered, reprocessed and their values for mineral exploration illustrated. The legacy data examples are from the Ludvika Mines (Nordic Iron Ore AB) of central Sweden and Neves-Corvo (Somincor-Lundin Mining) of southern Portugal.

In particular, through the development of a GPS-time system, we have managed to acquire a globally unique semi3D in-mine and surface seismic dataset at the world-class Neves-Corvo mine. This helped to utilize four exploration tunnels at 600 m depth and two receiver lines on the surface allowing over 1000 recorders to be synchronized for down-tunnel exploration. A broadband electromagnetic-based seismic source (7 kN or 1.5t), developed also in the project, was used as the seismic source.

In central Sweden, at an iron-oxide mining site of Nordic Iron Ore company, 2D seismic profiles helped to suggest potential resources in the down-dip continuation of the known deposits but also in their footwall. A follow-up and more recent survey employed over 1250 seismic recorders and a 32t vibrator to acquire a sparse 2 by 2 km seismic dataset. The data show great quality and allow to image lateral extent of the deposits and crosscutting reflections that may be important factors for mine planning and understanding structural evolution of the deposits. The broadband seismic source was also tested at the site along the existing 2D profiles with raw data already showing a

number of reflections interpreted to be from the mineralization. This survey further illustrates that the seismic source functions well and has a great potential for hard rock seismic applications.

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