High-tech and legacy data open new avenues to deep mineral exploration

There are challenges to deep mineral exploration whether in areas that have either been previously developed (brownfield) or could be developed anew (greenfield). The EU-funded Smart Exploration project is introducing solutions for both area types.

Introducing the project, coordinator Alireza Malehmir, professor at Uppsala University in the Department of Earth Sciences, notes: “The main goal of Smart Exploration is to develop cost-effective and environmentally friendly solutions for deep mineral exploration in brownfield and greenfield areas.” The work is centred on the development of five system prototypes and six improved methods for 3D imaging and modelling. “The newly acquired data, through the prototypes combined with the new methodologies, provide better target and geological characterisations at
greater depths,“ Malehmir reports.

**Mapping mineralisation**

The GPS-time synchronisation system (for denied-access environments such as underground mines) and an electric seismic source with broadband frequency (E-Vib) are two of the prototypes. These enabled the project team to conduct an up-scaling semi-3D surface and semi-3D underground seismic survey in the Neves-Corvo mine (Portugal) at 600 m depth. “Without the two systems, such a survey would be either impossible or only limited to 2D lines in a small survey area,” explains Malehmir. “We consider this survey a big leap forward for better targeting and thus potentially reducing costs and environmental impact from mining activities.”

Project partners have also used improved algorithms to successfully recover and reprocess a number of legacy data sets. While specifically relevant to the Neves-Corvo mine and Ludvika mines in Sweden, this feat underscores the value to be gained from the use of appropriate data and access to it. “Your next orebody might be in your legacy data,” Malehmir points out.

Other achievements cover activities at Finland’s Siilinjärvi phosphate mine. Here, Smart Exploration was able to characterise the ore from the waste rock and to map vertical faults that could act on the stability of the mine wall.

**Greenfield innovations**

The project’s validation sites have either primary resources (EU-listed critical raw materials) or host them as secondary resources. Malehmir explains that in certain sites, steep topography makes it extremely difficult to impossible to use conventional geophysical methods for rock characterisation and structure imaging. “As a solution, the developed helicopter transient electromagnetic method (HTEM) prototype, which has already been tested at the Ludvika brownfield site, will be flying over our greenfield sites in Greece and Kosovo to detect deep targets.”

Smart Exploration also employed machine learning algorithms to reinterpret existing geochemical-geological-geophysical data, providing potential porphyry Au-Cu (gold and copper) targets in Greece. “The innovation here lies in the way the data have been harmonised and validated through geostatistical approaches,” the coordinator reveals.

**Looking ahead**

Project partners also had to overcome challenges off the slopes. The teams adopted agile engineering in instances where delivery of parts was delayed, and they built a custom-made drone to reduce noise level in the unmanned aerial vehicle system.

Next on the agenda is exploitation and commercialisation. Smart Exploration will introduce the solutions to relevant companies through exploitation tours, mining events, workshops and direct engagement. In the meantime, “Smart Exploration supports more than 20 young professionals from academia, SMEs and
mining companies,” Malehmir concludes. “This younger generation is the key asset for the mineral exploration industry but also maybe future entrepreneurs who have learned how collaborative work can lead to commercial solutions and open up new businesses.”

Keywords

Smart Exploration, mineral exploration, greenfield, mining, legacy data, brownfield, geological, geophysical, 3D imaging, seismic survey, agile engineering

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