

NEWSLETTER – June - 2021

Uppsala University (UU)

The X-MINE project is focused on developing novel X-Ray Fluorescence (XRF) and X-ray Transmission (XRT)-sensing technologies integrated with drill core scanning and mineral sorting. The contributions from the Uppsala University to the project include mineralogical and textural characterisation of the ores in the targeted mines in the project, determining the concentrations and distribution of trace and critical metals and understanding the 4D evolution of the deposits.

Mineralogical and textural characterisation

The mineralogy of the ore deposits is used as input data for the XRF-XRF drill core scanning. Defining the mineralogy is thus critical for improving and validating the results. A detailed mineralogical and textural characterization using optical and electron microscopy, energy- and wavelength dispersive spectrometry (EDS and WDS), powder X-Ray diffraction (XRD) and Raman spectroscopy has been carried out for the targeted mines (operated by Lovisagruvan, Sweden; Assarel-Medet, Bulgaria; Hellas Gold, Greece and Hellenic Copper Mines, Cyprus).





Figure 1. An example of a pyrite crystal from the Three Hills deposit (Hellenic Copper Mines) showing early colloform-type pyrite overgrown by euhedral pyrite.

Figure 2. An example of the mineralogical and textural characterisation, here showing a sample of the ore zone at Mavres Petres (Hellas Gold) with different generations of sulphides.



XRF-XRT scanning revealing mineral textures

The XRF-XRT drill core scanning technology can be applied to study different meso- to micro-scale textures of the ores. It has proven useful for mineralogical studies at the Lovisa deposit where it allows for detailed visualisation and chemical characterisation of a wide range of textures related to metamorphism and deformation.



Figure 3. An example of a scanned half-core piece from Lovisa depicting the layered style of the ore and the occurrence of cross-cutting sulphide-quartz fracture infillings.



Figure 4. An example of a scanned half-core section from the Lovisa mine depicting the euhedral shape of garnet porphyroblasts and small minerals with high attenuation (in red; probably sulphides).



Trace and critical metal concentration and distribution

Which minerals are hosting the trace and critical metals and at which concentrations do they occur? The distribution of trace and critical metals for the different mines has been studied employing electron microprobe analysis (EMPA) and laser-ablation inductively coupled mass spectrometry (LA-ICP-MS).



Figure 5. Box and whisker plots comparing the concentrations of Au hosted in pyrite and arsenopyrite originating from the same sample from the Mavres Petres deposit (Hellas Gold). When both minerals co-exist, arsenopyrite is the preferred host but pyrite is the more abundant ore mineral and is thus the primary carrier of Au.

Figure 6. An example of a zoned pyrite crystal mapped with EMPA from East Apliki (Hellenic Copper Mines) showing the distribution of As, Se, Co and Ni.





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Figure 7. An example of a LA-ICP-MS trace element map showing the zonation of the pyrite and the distribution of different elements in pyrite and surrounding sphalerite from the Mavres Petres deposit (Hellas Gold)

The 4D evolution

In order to understand the 4th dimension of the deposits, U-Pb geochronology has been conducted using secondary ionisation mass spectrometry (SIMS) on zircon crystals.



Figure 8. Example of zircon crystals imaged by back scattered electrons (BSE) and used for U-Pb geochronology. The three zircons to the left are from the ore zone in Assarel-Medet. One zircon has an older core and all crystal have rims formed during the mineralisation. The three zircon crystals to the right is from an andesite that is associated with the ore-forming fluids.



The results from the four-year H2020 funded X-MINE project will be presented in an on-line Final Event on **23 June 2021 from 10:00 to 17:00 EET**.

The event will demonstrate how implementation of the new XRF-XRT-technology in scanning of exploration drill core, collection of data for 3D-modelling of ore deposits and sorting of minerals can improve the efficiency in exploration and increase the sustainability of mining operations.

You are welcome to register for the event on the X-MINE project website www.xmine.eu

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