Multi-source Hyperspectral Imaging of Drill-cores for the Exploration of Sedimentary Base-metal Deposits

Moritz Kirsch[1], Léa Géring[1], Samuel T. Thiele[1], Sandra Lorenz[1], Laura Tusa[2], Isabel C. Contreras Acosta[2], Andréa De Lima Ribeiro[1], Roberto De La Rosa[1], Houda Saffi[1], Richard Gloaguen[1]
1. Helmholtz-Zentrum Dresden-Rossendorf, Helmholtz-Institut Freiberg für Ressourcentechnologie, Freiberg, Germany, 2. TheiaX GmbH, Freiberg, Germany

The use of efficient and minimally invasive exploration technology in the mining sector is integral to sustaining the supply of raw materials in the future. Hyperspectral imaging is a spectroscopic technique that provides fast, high resolution, spatially continuous, and non-destructive mapping of mineralogy along drill cores. In this contribution we present a novel hyperspectral drill core scanning setup and processing workflow which we apply to mineralised cores from the Central European Kupferschiefer, one of the largest sediment-hosted accumulations of copper ores worldwide. For data acquisition, we use a Specim SisuROCK drill core scanner setup covering the visible-near infrared, shortwave, midwave and long-wave infrared spectral regions. The raw data are processed in near-real time using a custom-built processing pipeline that automatically identifies new datasets, applies sensor corrections and then co-registers the hyperspectral data from each sensor. Hyperspectral visualisations can then be virtually projected on the core using augmented reality to facilitate core logging activities and guide sampling. Innovative machine learning approaches are used for upscaling automated quantitative mineralogical data and lithological domaining. In our case study from the Spremberg-Graustein Cu-Ag deposit in Germany, we identified several spectral features associated with the occurrence of iron oxide, sulphates, kaolinite and carbonates. Whereas the iron oxides mark the oxidation along the path of the metal-bearing hydrothermal fluid in the sandstones immediately below the Kupferschiefer, Fe-rich carbonates and kaolinite are interpreted to represent products of hydrothermal alteration, as they delineate the position of high grade mineralisation. Changes in carbonate mineralogy also reveal fluid flow along styolites in carbonate rocks occurring stratigraphically above the main mineralized zone. The study suggests that hyperspectral imaging techniques are well suited to track hydrothermal fluid flow paths and vector towards base metal deposits in sedimentary basins and highlight the potential for real-time hyperspectral data acquisition and processing during drilling campaigns.