SEG 2024 Conference: Sustainable Mineral Exploration and Development

Development of New Exploration Vectors by Quantitative Mineralogical Analysis at the Spremberg-Graustein-Schleife Cu-Ag Kupferschiefer Deposit, Lusatia, Germany

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The Spremberg-Graustein-Schleife deposit is part of the Kupferschiefer district in the southern Permian Basin and comprises stratabound copper, silver, and other valuable and critical metals in mineralized rocks hosted by pre-Zechstein sandstones, Kupferschiefer, and Zechstein carbonates. Due to the significant exploration potential across the southern Permian Basin, the goal of the present study is to utilize mineralogical signatures as exploration vectors. The specific focus of this study is on gangue mineralogy, especially solid solutions such as carbonates and dioctahedral micas since their quantitative and compositional changes can potentially provide a larger detectable footprint in the mineralizing system. All samples and data from the last drilling campaigns were provided and discussed by KSL GmbH.

Multiple analytical methods were combined to investigate samples from three mineralized and nonmineralized drill cores. Scanning electron microscope (SEM)-based image analysis (MLA) was carried out to obtain quantitative data on mineralogy as well as major-element carbonate chemistry of each stratigraphic unit. Quantitative X-ray powder diffractometry was performed as an external validation. The mineral chemistry of carbonates and dioctahedral micas was studied by EPMA and LA-ICP-MS.

The Zechstein carbonates in the well-mineralized core are dominantly composed of dolomite, whereas in the weakly-mineralized core, calcite is the more abundant carbonate phase. Three successive generations of carbonate in the mineralized drill-hole were identified from backscatter electron (BSE) imaging, comprising (i) dolomite to (ii) Mn-Fe dolomite and (iii) ankerite rims. A quantitative comparison between dolomite and ankerite shows a correlated trend with the Cu-sulfide contents. Dioctahedral micas in the footwall sandstones were compositionally subdivided into muscovite and phengite, and the mineralized drill hole tends to contain more muscovite than the weakly mineralized drill hole. The marked mineralogical differences between well-mineralized and weakly-mineralized cores may indicate overprinting by mineralizing fluids and may thus be useable vectors toward mineralization.