

Organic-inorganic interactions as mineralization controls of the Early Permian sediment-hosted stratiform Cu deposit *Kupferschiefer* in Central Europe

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Organic-inorganic interactions in sedimentary basins are important reaction networks which also controlled how metals were precipitated in black shale in the geological past. An exemplary mineralization is the Permian Kupferschiefer system, a sediment-hosted stratabound copper (SSC) deposit in northern Central Europe. Early diagenetic porosity in carbonates (and feldspar) enabled metal-rich fluids to flow into and through the organic matter (OM)-rich shale T1 of the Kupferschiefer system and into the overlying Zechstein carbonate Z1, where they precipitated as metal sulphides. The timing and processes of this mineralization, particularly the role of organic matter (OM), remain a subject of ongoing debate. One possibility is that metal precipitation was controlled by redox reactions between reducing OM and oxidising fluids. However, the detailed mechanisms of this process remain poorly understood.

Given this background, we regard the Kupferschiefer system as a natural laboratory to study organic-inorganic interactions in mineralization processes. We used a variety of imaging and geochemical methods (open pyrolysis, thermovaporization, ICP-MS, STXM, TEM) to investigate whether the OM functioned as physical and/or geochemical seal, or trap; and whether it influenced interface reactions in porous microenvironments. The new data will be discussed based on known mineralogical and geochemical data of variously mineralized, altered and barren Kupferschiefer sections from a variety of geological settings in Germany.

Our data shows that the organic matter predominates as laminated and non-fluorescing pyrobitumen in the lower part of the “Kupferschiefer” T1 shale, and refer to fossilized algal mats probably due to pulsed productivity. In contrast to previously considered oxidation, strong aromatization correlates with elevated uranium content of up to 900 ppm, and indicates that its original structure was mainly altered by irradiation of α - and β -particles.

The organic matter was thus not just a reductant for precipitation of metal sulphides. It was more than that a factor for enhanced intra-shale sealing integrity against mineralizing aqueous fluids limiting the mineralization efficiency upwards as is observed in the Kupferschiefer. The reconstruction of processes leading to Kupferschiefer mineralization thus resembles those taking place in petroleum systems and/or those