



4D Geomodeling: a Tool for Targeting New Potential Mineralization – Example of the Kupferschiefer in the Lubin Region, Poland

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Understanding the history of sedimentary basins is of paramount importance for reconstituting oil and gas migration, but also in mineral exploration for identifying brine pathways. Advanced modeling technology such as 3&4D geomodeling can be fruitfully used to explore with new eyes old matured mining field. The Polish Kupferschiefer, a sediment-hosted polymetallic (Cu, Ag, Au, PGE) deposit, is one of the most important sources for copper and silver in the world. Within the framework of the ProMine European project, the Lubin region (south west of Poland), was selected for modeling in 3&4D the geological formations in order to better understand the distribution of the Cu-Ag mineralization, and possibly to define new potential targets. A regional scale 4D reconstitution of the North European basin was undertaken to better understand the burial, deformation and natural hydro-fracturing history of the Lubin Kupferschiefer. It comprises the creation of a 3D model of the present geological formation including more than 200 wells coming from the mining exploitation of the Kupferschiefer, cross sections from seismic exploration and geological maps. This 3D model has been then restored and decompacted using the Kine3D-2 Gocad plug-in. The PetroMode 1D was then used to reconstitute the temperatures, pressures, fluid overpressure, and oil and gas maturation during the burying history of the Southern-Western Poland basin. Conditions for hydraulic fracturing were identified within the base of the Zechstein shales, during an inversion phase at the Late Cretaceous-Early Paleocene time. This up-lifting yields the conditions for hydrothermal recirculation of mineralizing brines explaining the location of Cu (Cu-Fe) sul [U+FB01] des ores in the area. The low permeable Zechstein series (including evaporite, clays and marls) seem to have played an important role as an impermeable cover confining the hydrothermal fluids in the pre-Triassic series. The 4D restoring-decompacting modeling allows reconstituting the burial, deformation and natural hydro-fracturing history of intra-basin sediment-hosted ore deposits. In the Lubin region, the obtained results show a good agreement between the spatial hydro-fracturing index and the emplacement of the Cu (Cu-Fe) sulfides exploited today.

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