

Geological Controls and Spatial Patterns of Copper Belts in the Kupferschiefer Series of Poland

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Copper-silver mineralization in Poland represents one of the largest world-class sediment-hosted Kupferschiefer-type polymetallic ore systems. Economically viable Cu-Ag ores occur within the Kupferschiefer series, marking the Permian transition between the continental Rotliegend and marine Zechstein sequences. Kupferschiefer-type deposits formed from low-temperature, oxidizing, metal-bearing basinal solutions rich in chlorides. These fluids rose upward and flowed laterally along paleohigh flanks, passing through organic-rich, reduced sediments sealed by evaporites, which trapped mineralization. The early-to-late model explains distinct metal and mineral zonation controlled by the Rote Fäule oxidized redox front. Investigations beyond the Lubin-Sieroszowice Copper District show the Kupferschiefer series contains substantial Cu-Ag resources rimming oxidized areas. They form extensive copper belts dominated by high-grade Cu-sulfides such as chalcocite and bornite. Outwards from the copper-rich zone, the mineral assemblage shifts to chalcopyrite-galena-sphalerite and peripheral pyrite zones. Major copper belts are in the southern Fore-Sudetic Monocline (Lubin-Mozów, Sulmierzyce-Dębica), with smaller belts in the Żary Pericline (Czeklin-Żarków, Żary) and North Sudetic Synclinorium (Konrad-Lena). The northern Fore-Sudetic Monocline hosts Cu-rich bodies along the Wolsztyn-Pogorzela High, with the Kaleje-Żerków belt containing the highest-grade mineralization. Evidence from these belts underscores the importance of integrating lithological, structural, geochemical, and genetic criteria to delineate prospective areas. This approach aids in identifying economically significant ore prospects and provides a framework for exploration in complex sedimentary and structural settings. Based on previously identified copper belts, which include 36 prospective areas, recent multidisciplinary exploration documented four major Cu-Ag deposits: Nowa Sól, Sulmierzyce North, Mozów, and Żary. These results increase the estimated Cu-Ag resources in Poland. Driven by market demand, the Cu-Ag mining industry is increasingly exploring other valuable elements, including Pb, Zn, Co, Ni, Se, Re, Au, PGE, and REE+Y.