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Insights into the Origin of Sedimentary-Hosted Copper Mineralization in Kazakhstan

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Kazakhstan has historically produced copper from the world-class Dzhezkazgan mining complex (2.0 Bt @ 1.1% Cu for 22 Mt Cu) located in the northern Chu-Sarysu basin, which is the third largest endowed sediment-hosted copper basin globally. Also, the Zhaman-Aibat deposits (160 km SE of Dzhezkazgan) and the Zhilandy group of deposits (located in northern Dzhezkazgan) bear significant copper mineralization in the Chu-Sarysu basin (Box et al., 2012). In addition, the Teniz basin located north of the Chu-Sarysu basin, separated via uplift from the basin, is the current prospect for copper. Mineralization is related to middle-late Carboniferous and Permian fluvial red-bed sequences. The Chu-Sarysu and Teniz basins are characterized by a continental-marine-continental depositional cycle from Devonian to Permian. Comparison of stratigraphic columns of both basins shows correlation at the base of the Dzhezkazgan and Vladimirov Formations (Chu-Sarysu and Teniz basins, respectively); marking several upward-fining clastic sequences of alluvial-lacustrine red beds (hosting most of the mineralized horizons) above Lower Carboniferous platform carbonates (lagoonal to marginal-marine salt-bearing strata) (Cossette et al., 2014). Occurrence of copper is structurally controlled adjacent to the intersection of F_2 anticlines (N-NW-trending) with the syn-depositional folding F_1 anticlines (E-NE-trending) within the zones of sandstone bleaching. The F_1 anticlines locally trapped petroleum deposits. These structures are the pathway of the flow of dense ore brines across the petroleum-bearing anticlines, resulting in ore sulfide deposition most likely via mixing of two fluids. The copper originates likely from Early to Middle Devonian intermediate volcanic and volcanoclastic basement rocks.

At regional scale, the formation of both basins can be the result of oroclinal bending of Permian Kazakhstan, generating a back-arc/rift-graben development. This is reflected in parallel strike-slip lineaments in eastern and western parts of the basins. Satellite images are interpreted to locate major structures within the basins, which can assist in further exploration.