

Sandstone-Hosted Copper Mineralization in Oligo-Miocene-Red-Bed Strata, Chalpo North East of Iran: Constraints from Lithostratigraphy, Lithogeochemistry, Mineralogy, Mass Change Technique, and Ree Distribution

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Abstract : The Chalpo copper area is located in northeastern Iran, which is part of the structural zone of central Iran and the back-arc basin of Sabzevar. This sedimentary basin accumulated in destructive-Oligomiocene sediments is named the Nasr-Chalpo-Sangerd (NCS) basin. The sedimentary layers in this basin originated mainly from Upper Cretaceous ophiolitic rocks and intermediate to mafic-post ophiolitic volcanic rocks, deposited as a nonconformity. The mineralized sandstone layers in the Chalpo area include leached zones (with a thickness of 5 to 8 meters) and mineralized lenses with a thickness of 0.5 to 0.7 meters. Ore minerals include primary sulfide minerals, such as chalcocite, chalcopyrite, and pyrite, as well as secondary minerals, such as covellite, digenite, malachite, and azurite, formed in three stages that comprise primary, simultaneously, and supergene stage. The best agents that control the mineralization in this area include the permeability of host rocks, the presence of fault zones as the conduits for copper oxide solutions, and significant amounts of plant fossils, which create a reducing environment for the deposition of mineralized layers. Statistical studies on copper layers indicate that Ag, Cd, Mo, and S have the maximum positive correlation with Cu, whereas TiO_2 , Fe_2O_3 , Al_2O_3 , Sc, Tm, Sn, and the REEs have a negative correlation. The calculations of mass changes on copper-bearing layers and primary sandstone layers indicate that Pb, As, Cd, Te, and Mo are enriched in the mineralized zones, whereas SiO_2 , TiO_2 , Fe_2O_3 , V, Sr, and Ba are depleted. The combination of geological, stratigraphic, and geochemical studies suggests that the origin of copper may have been the underlying red strata that contained hornblende, plagioclase, biotite, alkaline feldspar, and labile minerals. Dehydration and hydrolysis of these minerals during the diagenetic process caused the leaching of copper and associated elements by circling fluids, which formed an oxidant-hydrothermal solution. Copper and silver in this oxidant solution might have moved upwards through the basin-fault zones and deposited in the reducing environments in the sandstone layers that have had abundant organic matters. Copper in these solutions probably was carried by chloride complexes. The collision of oxidant and reduced solutions caused the deposition of Cu and Ag, whereas some stable elements in oxidant environments (e.g., Fe_2O_3 , TiO_2 , SiO_2 , REEs) become unstable in the reduced condition. Therefore, the copper-bearing sandstones in the study area are depleted from these elements resulting from the leaching process. The results indicate that during the mineralization stage, LREEs and MREEs were depleted, but Cu, Ag, and S were enriched. Based on field evidence, it seems that the circulation of connate fluids in the red-bed strata, produced by diagenetic processes, encountered to reduced facies, which formed earlier by abundant fossil-plant debris in the sandstones, is the best model for precipitating sulfide-copper minerals.

Keywords : Chalpo, oligo-miocene red beds, sandstone-hosted copper mineralization, mass change, LREEs, MREEs

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