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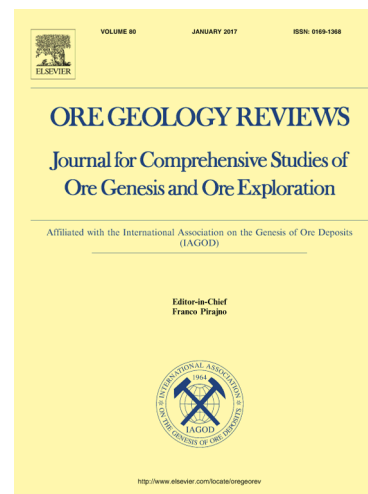
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Geology and geochemistry of the sediment-hosted Cheshmeh-Konan redbed-type copper deposit, NW IranShahrokh Rajabpour ^{a,b,*}, Ali Abedini ^b, Samad Alipour ^b, Bernd Lehmann ^c, Shao-Yong Jiang ^{d,e}^a *Geology Department, Faculty of Earth Sciences, Shahid Beheshti University, Tehran, Iran*^b *Geology Department, Faculty of Sciences, Urmia University, Urmia, Iran*^c *Mineral Resources, Technical University of Clausthal, 38678 Clausthal-Zellerfeld, Germany*^d *State Key Laboratory of Geological Processes and Mineral Resources, Collaborative Innovation Center for Exploration of Strategic Mineral Resources, Faculty of Earth Resources, China University of Geosciences, Wuhan 430074, China*^e *State Key Laboratory for Mineral Deposits Research, Department of Earth Sciences, Nanjing University, Nanjing 210093, China*

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Abstract

The several-hundred-m-thick Miocene Upper Red Formation in northwestern Iran hosts stratiform and fault-controlled copper mineralization. Copper enrichment in the percent range occurs in dm-thick carbonaceous sandstone and shale units within the clastic redbed sequence and consists of fine-grained disseminated copper sulfides (chalcopyrite, bornite, chalcocite) and supergene alteration minerals (covellite, malachite and azurite). The copper mineralization formed after calcite cementation of the primary rock permeability. Copper sulfides occur mainly as replacement of diagenetic pyrite, which, in turn, replaced organic matter. Electron microprobe analysis on bornite, chalcocite and covellite identifies elevated silver contents in these minerals (up to 0.12, 0.72 and 1.21 wt.%, respectively), whereas chalcopyrite and pyrite have only trace amounts of silver (<0.26 and 0.06 wt.%, respectively). Microthermometric data on fluid inclusions in authigenic quartz and calcite indicate that the Cu mineralization is related to a diagenetic fluid of moderate-to low temperature (Th= 96 to 160°C) but high salinity (25 to 38 wt.% CaCl₂ equiv.). The range of $\delta^{34}\text{S}$ in pyrite is -41.9 to -16.4‰ (average -31.4‰), where framboidal pyrite shows the most negative values between -41.9 and -31.8‰, and fine-grained pyrite has relatively heavier $\delta^{34}\text{S}$ values (-29.2 to -16.4‰), consistent with a bacteriogenic derivation of the sulfur. The Cu-sulfides (chalcopyrite, bornite and chalcocite) show slightly heavier values from -14.6 to -9.0‰, and their sulfur sources may be both the precursor pyrite-S and the bacterial reduction of sulfate-bearing basinal brines. Carbonates related to the ore stage show isotopically light values of $\delta^{13}\text{C}_{\text{V-PDB}}$ from -8.2 to -5.1 ‰ and $\delta^{18}\text{O}_{\text{V-PDB}}$ from -10.3 to -7.2 ‰, indicating a mixed source of oxidation of organic carbon (ca. -20 ‰) and HCO_3^- from seawater/porewater (ca. 0 ‰). The copper mineralization is mainly controlled by organic matter content and paleopermeability (intragranular space to large fracture patterns), enhanced by feldspar and calcite dissolution. The Cheshmeh-Konan deposit can be classified as a redbed-type sediment-hosted stratiform copper (SSC) deposit.

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