

Physicochemical Condition Controlling Mineralization and Alteration at the Miduk porphyry copper deposit, southern Iran

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<http://ksgeo.kj.yamagata-u.ac.jp/~nakashi/index.html>

The Miduk porphyry copper deposit is located 42 km northeast of Shar-e-Babak, southern Iran. The Cu mineralization and associated hydrothermal alteration zones are focused on the Miocene dioritic Miduk porphyry and Eocene andesitic rocks. The concentric alteration zones from the centre outward are potassic, phyllic, and propylitic. The dominant mineral assemblage in the potassic zone is by K-feldspar, quartz, relict plagioclase, biotite, sericite, pyrite, chalcopyrite, magnetite, and ilmenite with subordinate anhydrite, chlorite, zircon, apatite, titanite, rutile, hematite, and other clay minerals. Phyllic alteration is characterized by a high density of stockwork veins and veinlets. Quartz is the most abundant mineral and occurs as disseminated grains and stockwork veins and veinlets reflecting multiple stages of generation. Late pyrite veins (from a few mm to a few cm width) comprise about 10-20 vol% of the altered rocks in the phyllic zone and typically exhibits complete replacement of the primary assemblage. The argillic alteration assemblage is characterized by small veins or relict islands of clay (mainly kaolinite), pyrite and quartz associated with relict K-feldspar. The propylitic alteration assemblage is characterized by epidote, chlorite, sericite, quartz, calcite, and clay minerals, which replaced biotite, hornblende, plagioclase, and a similar groundmass.

The area of mineralization is divided into three ore types; deeper hypogene sulfides, near-surface supergene sulfides, and supergene oxides. The deeper hypogene sulfide minerals mainly occur as disseminated blebs and veins and consist of pyrite and chalcopyrite. In the phyllic alteration zone, the first hypogene sulfide is pyrite followed by hypogene chalcopyrite and pyrite. Tiny grains of other ore minerals are bornite and enargite. The supergene sulfide zone is also characterized by chalcocite and digenite stockwork veins and veinlets. Chalcopyrite and pyrite are completely or partially replaced by chalcocite, digenite, and covellite. The near-surface exposed hypogene ores were subjected to supergene desulfidation and couple oxidation processes; sulfides have been replaced by Fe-hydroxides, Cu-oxides, Cu-carbonates, Cu-phosphates, Cu-sulfates, and Cu-silicates to form a leached cap and oxide zone. Turquoise veins are surprisingly abundant in this zone and occurs at shallow depths and along fractures in deep parts of the mine. Primary and secondary quartz in the potassic zone contain two phase, vapor-rich and multiphase fluid inclusions. The total homogenization of the solid-bearing fluid inclusions mainly occurs to the liquid phase by final dissolution of halite. Average homogenization temperature of multiphase fluid inclusions occurs at about 430 degree-C (n=40). Homogenization temperatures range from 320 to 550 degree-C. Average salinity of multiphase fluid inclusions is 51+/-7 wt.% NaCl eq. The salinities range from 40 to 67 wt.% NaCl eq.

Like other porphyry copper deposits, the potassic alteration zone was caused by fluids with high aK^+/aH^+ . As magmatic hydrothermal fluids rose, the hot (less than 550 degree-C) boiling ore-forming fluids with salinity of less than 65 wt.% NaCl eq. generated potassic alteration and the first stage of hypogene mineralization. Oxygen fugacity (fO_2) and pH evidence shows chalcopyrite was precipitated under high fO_2 at high temperature in the potassic alteration zone (about 500 degree-C). Therefore, chalcopyrite could have deposited in response to an increasing in pH that accompanied biotitization, decreasing T of the reacting fluids, and related increase H_2S/SO_2 , as well as boiling. As fluids rose through the fracture network, the further decreasing temperature resulted in dissociation of acids and an increase in acidity to form the phyllic zone.