Fluid inclusion studies in quartz veinlets of the Darreh-Zereshk and Ali-Abad porphyry copper deposits, central Iran

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The porphyry copper deposits at Darreh-Zereshk and Ali-Abad are located southwest of the Yazd city, central Iran. The porphyries occur as granitoid intrusions, ranging in composition from quartz monzodiorite through granodiorite to granite, hosting copper ore that exhibits intense, hydrofracturing that lead to the formation of veinlets of quartz and sulphides. Four types of alteration are recognized within the ore zones, potassic, phyllic, propylitic, and argillic. The potassic alteration was developed in granitoid rock near the core of the mineralized zone and surrounded by other types of alteration.

Fluid inclusions in the deposits can be classified as a monophase Type I (vapour), liquid-rich Type IIA (liquid + vapour), vapour-rich Type IIB (vapour + liquid), and multi-phase (liquid + vapour + halite + sylvite + hematite + chalcopyrite and pyrite) Type III. Homogenization temperatures and salinity data are presented for fluid inclusions from hydrothermal quartz veinlets associated with hypogene mineralization. Ore

precipitation occurred between 150° to 600°C from low to high salinity (1.1–73.9 wt% NaCl equiv.) aqueous fluids. Two stages of hydrothermal activity characterized by high salinity (> 40 wt% NaCl equiv.) are recognized; one which occurred at relatively high temperature and lower salinity fluid (Type IIIa; $Th_{(L-V)} > Tm_{(NaCl)}$); and one which took place at lower temperature and higher salinity (Type IIIb; $Th_{(L-V)} < Tm_{(NaCl)}$). The high $Th_{(L-V)}$ and salinities of Type IIIa inclusions are interpreted to represent the initial existence of dense fluid of magmatic origin. The coexistence of Type IIIb and Type I and Type IIB inclusions suggest that these fluid inclusions resulted either from trapping of boiling fluids and/or represent two immiscible fluids. These processes probably occurred as result of pressure fluctuations from dominantly lithostatic to hydrostatic conditions, under a pressure of 200 to 300 bar, corresponding to a depth of 2 to 3 km assuming hydrostatic pressure and 1 to 1.5 km assuming lithostatic pressure. Dilution of these early fluids by convecting meteoritic water resulted in low temperature and low to moderate salinity (< 20 wt% NaCl equiv.) fluids (Type IIA). Fluid inclusion analysis reveals that the hydrothermal fluid, which formed quartz mineralized veinlets in the rocks with potassic alteration, had temperatures of ~ 500° and salinity ~ 50 wt% NaCl equiv. Cryogenic SEM analyses of ore-bearing fluids trapped in the inclusions indicate the fluids were dominated with NaCl, KCl and minor $CaCl_2$.