Fluid inclusions and evolution of ore fluids in the Baghkhoshk porphyry copper system, Urumieh- Dokhtar magmatic belt, Iran

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The Baghkhoshk porphyry copper system is located south of the Cenozoic Urumieh-Dokhtar magmatic belt in Iran (~15 km SE of the giant Sarcheshmeh Cu-Mo-Au porphyry deposit). The hypogene mineralization in Baghkhoshk occurs within two Miocene intrusions (an older granular granodiorite and a younger porphyritic quartz-diorite) and their enclosing Eocene volcanic-sedimentary rocks. Both intrusions and their host rocks are extensively altered by hydrothermal fluids into potassic, phyllic, and propylitic assemblages. The deposit was first discovered in early 1970s, and the ore reserve was reported to be 24 million tons at 0.27 % Cu (Nedimovic, 1973). The deposit is currently under detailed exploration by deep diamond drillings. This paper presents data on the fluid inclusions and evolution of the ore fluids in the Baghkhoshk porphyry system.

Based on the mineralogy and crosscutting relationships, two main types of veinlets associated with potassic and phyllic alterations can be distinguished: 1) quartz + chalcopyrite + pyrite ± molybdenite (mineralized veinlets); and 2) quartz ± pyrite (barren veinlets).

Heating and freezing experiments were conducted on a Linkam MDS600 stage attached to an Olympus BX40 microscope in the Department of Applied Geosciences and Geophysics, University of Leoben, Austria. For freezing runs, the precision is about ±0.3 °C for melting CO_2 and ±0.2 °C for ice melting; for heating runs, the precision is about ±1 °C for critical point of H_2O. The stage was calibrated with synthetic fluid inclusions of CO_2 and H_2O. Composition of the fluid inclusions was analyzed by Raman microspectroscopy at Leoben using a LABRAM Jobin-Yvon system.

Fluid inclusions petrography

Three types of fluid inclusions were identified in various types of quartz veinlets: 1) Poly-phase inclusions; 2) Vapour-rich inclusions; 3) Liquid-rich inclusions. The poly-phase inclusions always contain vapour bubble, a saline aqueous liquid and halite (Fig. 1a). The poly-phase brine inclusions contain additional opaque daughter crystals including small red hematite flakes and triangular chalcopyrite, the former being more frequent.

The vapour-rich inclusions contain vapour + liquid ± solid phase. The solid phase is triangular chalcopyrite crystals as indicated by Raman microspectroscopy (Fig. 1b). Vapour bubbles are variable in size, but in all cases consist of > 60 % of inclusion volume.

The liquid-rich inclusions are the most abundant type in Baghkhoshk. They consist essentially of liquid and vapour with the latter forming < 30 % of inclusion volume. The boiling trails (vapour-rich+ liquid-rich inclusions) observed in the quartz veinlets associated with potassic and phyllic alteration (Fig. 1c). The barren quartz± pyrite veinlets contain only liquid-rich inclusions.

Microthermometry:

The liquid-rich inclusions, homogenizing by vapour disappearance, display a wide range of homogenization temperatures, varying from 128.5 to 383.8 °C, with most measurements are between 200-250 °C and 300-375 °C. Liquid-rich fluid inclusions have salinity values between 0.35 to 24.24 eq mass% NaCl, with most measurements in the range 4 to 10 eq mass% NaCl. The salinity and homogenization temperatures of barren veinlets are 2 to 4 eq mass% NaCl and 200-240 °C, respectively.

The poly-phase inclusions, homogenizing by vapour disappearance, display homogenization

temperatures from 191.8 to 382 °C, with a mode of 300 to 375 °C. The halite melting temperature in the poly-phase inclusions varies from 173.1 to 248.9 °C, and the salinity varies between 32.5 and 35 eq mass% NaCl.

The vapour-rich inclusions, homogenizing by liquid disappearance, range in T_h from 325.8 to 434 °C, with a mode at 400 – 425 °C. The salinities are low, 4 to 8 eq mass% NaCl.

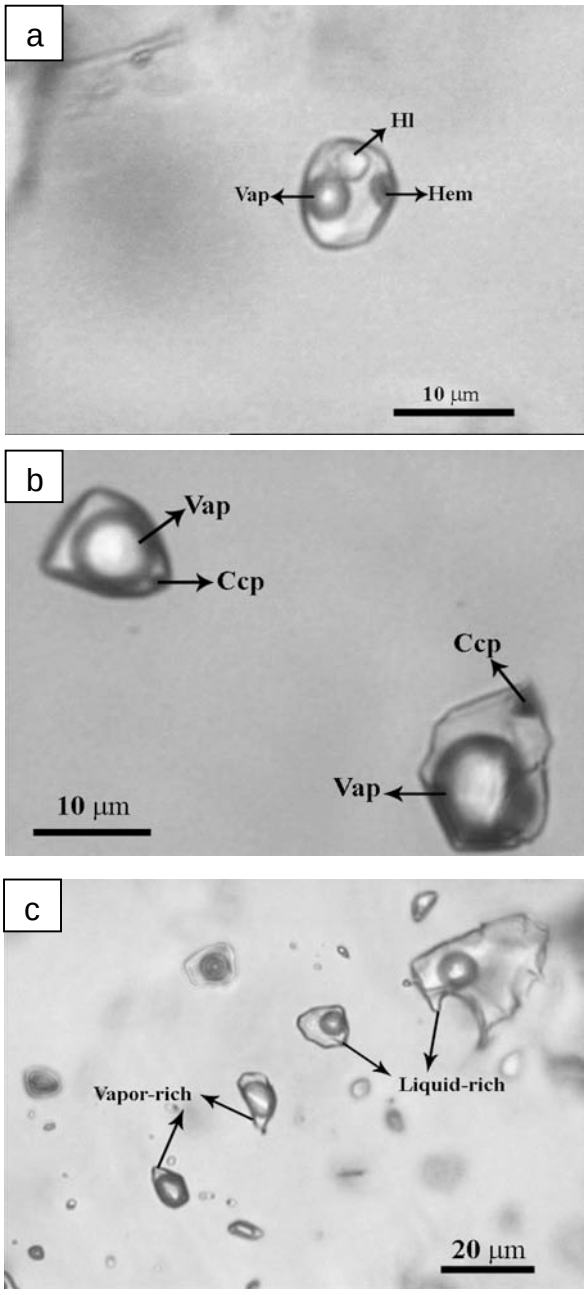

Fig. 1. Three main types of fluid inclusions at Baghkhoshk: a) Poly-phase inclusion; b) Vapour-rich inclusions; C) Boiling trail.

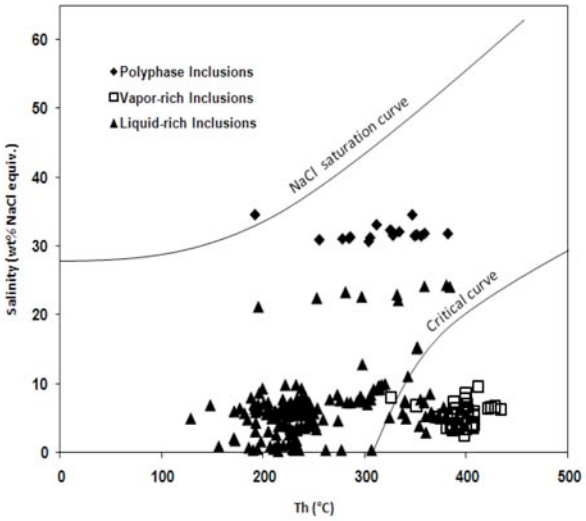

Fig. 2. Distribution of salinity and T_h values for various fluid inclusion types in Baghkhoshk. The NaCl saturation and critical curves from Ahmad and Rose (1980).

Results:

The ore deposits at Baghkhoshk developed from fluids with originally low-moderate salinities (6 to 8 mass% NaCl) at temperatures varying from 350 to 425 °C.

Our observations demonstrate that boiling occurred during potassic and phyllic alterations. Fluid inclusion evidence indicates that phase separation (boiling) was important and likely the main cause of heat loss and ore deposition (*c.f.* Hezarkhani and William-Jones, 1998).

The temperature and salinity of the fluids associated with phyllic alteration decreased from 375 °C to 200 °C and 32.5 - 35 to 4 - 10 eq mass% NaCl, respectively. This could be explained by mixing with a low temperature fluid (likely meteoric water).

REFERENCES

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