



Mineralogy, occurrence of mineralization and temperature-pressure conditions of the Agh-Daragh polymetallic deposit in the Ahar-Arasbaran metallogenic area

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Introduction

The Ahar-Arasbaran metallogenic area (Qara Dagh zone) is located in the northwest of Iran and the western part of the Mazandaran Sea. At the base of the structural classification from Nabavi (1976), this area is situated in the Alborz-Azerbaijan magmatic belt. Sheviar Dagh (Ahar batholite) intrusive suite, subvolcanic and volcanic accompanied rocks with east-west trending and 30 km long serves as the main Eocene-Oligocene magmatic event in the north of the Ahar province. Considering geochemistry, this assemblage includes two shoshonitic and calc-alkaline to high-K calc-alkaline series which are the shoshonitic series in the central part and the calc-alkaline series outcrop in the western and eastern part (Aghazadeh, 2009). Textural characteristic, mineral chemistry and fluid inclusion studies were carried out at the tree part of the Agh-Daragh prospecting area.

Material and methods

A total of 50 samples were collected from the host rocks (including 4 trench and 250 m), ore deposit and altered rocks. Ten altered samples were analyzed for their mineral recognition by X-ray diffraction in the Iran Mineral Process and Research Center (IMPRC). Electron microprobe analyses (EMPA) and backscattered electron (BSE) images of minerals were obtained using a Cameca SX100 electron microprobe in the Iran Mineral Process and Research Center (IMPRC). An accelerating voltage of 15 to 25 kV and beam current of 20 mA was used for all analyses. Typical spot sizes ranged from 2 to 5 μm . A total of 5 double-polish thin sections representative of quartz samples were selected from mineralized veins after petrographic and field

studies. Fluid inclusion microthermometry was conducted using a Linkam THMS600 heating–freezing stage (-190°C to $+600^{\circ}\text{C}$) mounted on a ZEISS Axioplan2 microscope in the fluid inclusion laboratory of the school of Earth Sciences of the Kharazmi University. The heating rate was 5–10 $^{\circ}\text{C}/\text{min}$ at higher temperatures ($>100^{\circ}\text{C}$), with a reproducibility of $\pm 1^{\circ}\text{C}$. However, it was reduced to 0.1–0.5 $^{\circ}\text{C}/\text{min}$ near phase transformation, with a reproducibility of $\pm 0.1^{\circ}\text{C}$.

Results

Mineralization that occurs in the area is mainly related to the Sheviar Dagh intrusive rocks and it includes a variety of types of skarn, porphyry- and vein-type, epithermal and intrusion related deposits. Agh Daragh mineralization occurs at least in three states including: 1) stockwork-disseminated, 2) vein-type and 3) replacement (skarn). In order to determine the nature and characteristics of granodiorites hosted Ayran Goli mineralization, the biotites points were analyzed. The Ayran Goli granodiorite with calc-alkaline nature is related to orogenic zones that is associated with subduction zones. To determine the chemical properties of the minerals in Gowdal skarn mineralization, garnet and chlorite have been used for analysis which are often located at repidolite and pinochlorite positions. Electron micro probe analysis (EMPA) of magnetite from the Chupanlar area showed that it belongs to porphyry and Kiruna type deposits. Based on the observations made, three types of aqueous fluid inclusions were distinguished in the quartz-sulfide veins, including halite-saturated aqueous ($\text{H}_2\text{O}-\text{NaCl}\pm\text{KCl}$), aqueous

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two-phase ($\text{H}_2\text{O}-\text{NaCl}\pm\text{CaCl}_2$), and monophasic liquid and vapor fluid inclusions.

Discussion

Because of the lack of CO_2 -bearing fluid inclusions phase in the samples, we used a temperature-pressure relationship intersection in order to obtain the depth of mineralization. However, but at this study salt-rich inclusions (type 1) the dissolution of halite homogeneous solid phase (Bodnar, 1994) were used in order to estimate the standing deposit. Considering the temperature of the liquid-vapor homogenization ($T_{h,v}$), temperatures between 201 to 474°C, homogenization halite ($T_{m_{\text{NaCl}}}$) between 196 to 434°C (48 wt% NaCl eq.) in the solid phase inclusions with halite, minimum and the maximum pressure between 4.0 and 7.2, respectively that occur at 0.4 to 2.7 kb (average of 5.1 kb and 4 km depth) under lithostatic pressure. These conditions are consistent with the occurrence of gold porphyry copper deposits introduced by Hedenquist et al., (1998). The presence of gas-phase inclusions (type 3), gas-rich (type 2) and a solid-bearing phase, halite (type 1) in a mixture of fluid inclusions indicates the occurrence of fluid immiscibility (Bodnar, 1995; Fournier, 1999). In such circumstances, homogenization temperature inclusions are trapped as their temperature is taken. Petrographic evidence on the simultaneous presence of these two categories is stored as the initial fluid temperature up 400 to 500°C with boiling and fluid immiscibility.

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