



## Geochemistry, Fluid Inclusion and Sulfur Isotopes Studies of Hydrothermal Breccia Gold Mineralization in the Khunik Area, Khorasan Jonoubi Province (Iran)

Somayeh Samiee<sup>1&2\*</sup>, Majid Ghaderi<sup>3</sup> and Sedigheh Zirjanizadeh<sup>2</sup>

1) Department of Geology, Faculty of Science, Ferdowsi University of Mashhad, Mashhad, Iran

2) Department of Geology, Faculty of Sciences, University of Gonabad, Gonabad, Iran

3) Department of Geology, Faculty of Basic Sciences, Tarbiat Modares University, Tehran, Iran

Submitted: Mar. 07, 2017

Accepted: July 30, 2018

**Keywords:** Mineralization, fluid inclusions, hydrothermal breccia, Khunik, Lut Block

### Introduction

The Khunik gold prospecting area is located 106 km south of Birjand, in the Khorasan Jonoubi province. The Khunik area is located in a strategic part of the Lut Block that includes many instances of mineralization such as the Qaleh Zari IOCG deposit (Karimpour et al., 2005; Richards et al., 2012), the Maherabad porphyry-type Cu-Au (Malekzadeh Shafaroudi et al., 2010, 2015), the Cu porphyry type of Dehsalm (Arjmandzadeh, 2011), the Kooch-Shah (Abdi et al., 2010) and the Hired intrusion-related (reduced type granitoid) gold deposit (Karimpour et al., 2007). According to geology, alteration, geochemistry and mineralization evidence the Khunik area is a hydrothermal breccia gold system. The important styles of mineralization are: hydrothermal breccia, veinlet and disseminated. The maximum gold concentration occurs along the hydrothermal breccia zone. The aim of this study is surface and deep investigation of alteration, mineralization and geochemical characteristics of hydrothermal breccia as the most important part of mineralization in the Khunik area.

### Materials and methods

Two hundred samples were collected from both surface and drill holes. Mineralization and paragenesis of the system were studied based on

150 polish and thin polish sections.

Doubly polished thin sections were prepared for twelve samples containing quartz and calcite. Based on detailed petrography study of the fluid inclusion, representative fluid inclusions were selected for the measurement. Using a Linkam TH600 heating- freezing stage attached to a Zeiss transmitted light microscope at the Ferdowsi University of Mashhad, Iran. six pyrite samples prepared for conventional isotopic analysis were sent to the Isoanalytical laboratory in England.

### Results

There are several outcrops of granitoid subvolcanic intrusions as dykes and stocks in the area which intruded volcanic rocks. The subvolcanic bodies consist mainly of diorite, monzonite and monzodiorite. In addition, they include hydrothermal breccia outcrops in the area. Alteration in the Khunik area is related to some intrusives. Exposed alterations at the surface are: propylitic, argillic, hydrothermal breccia and carbonate. Alteration zones at depth are: quartz-sericite-pyrite, quartz- tourmaline, carbonatization and less argillic.

Mineralization is related to subvolcanic units with an age of 38.4 Ma. Mineralization outcrops in the central portion of the area are as disseminated, veinlet, and hydrothermal breccia. Hydrothermal

\*Corresponding authors Email: samiee85@yahoo.co.in

DOI: <https://doi.org/10.22067/econg.v11i3.71480>

breccia is the most important part of the mineralization in the central part of the Khunik area. This zone is about 730×750 meter.

The hydrothermal breccia is mostly mosaic to rubble monomictic breccia with hydrothermal cement. Detailed systematic mapping leads us to the recognition of two distinct breccia bases on cement: carbonate-quartz cement breccia and carbonate cement breccia. Mineralization occurs in both clast and cement of hydrothermal breccia and in the truncated veinlet. Metallic minerals are dominantly pyrite, and they contain chalcopyrite and tetrahedrite only in trace amounts. Based on the lithochemical data, the concentration of elements are as follows: Au: 2-4600 ppb, Ag: 40-980 ppb, Sb: 6.9-133.5 ppm, As: 0.5-158 ppm, Hg: 0.2-4.95 ppm, Cu: 21-601 ppm, Pb: 4-1485 ppm, Zn: 18-1095 ppm. Geochemical data in the drill cores indicated different anomalies in gold concentration. These anomalies are related to altered subvolcanic units to quartz-sericite-pyrite and hydrothermal breccia. Thermometric analysis was performed on L+V fluid inclusions. The result of Th vs. frequency and salinity vs. frequency plots indicate that quartz and calcite-hosted in the cement of hydrothermal breccia mineralization may have taken place between 300 to 430°C from a moderately saline hydrothermal fluid (2-12 wt.% NaCl equiv.). The presence of hydrothermal breccia is consistent with boiling. The average calculated  $\delta^{34}\text{S}$  H<sub>2</sub>S values for clast and cement of hydrothermal breccia are respectively -2.4‰ and 0.9‰ for pyrite that are consistent with a magmatic source for sulfur (Andrew et al., 2008). Gold deposition at hydrothermal breccia is inferred to have been largely by boiling, although mixing with meteoric waters may have also occurred.

### References

- Abdi, M., Karimpour, M.H. and Najafi, A., 2010. Geology, alteration and mineralization potential of Kuh-Shah region, South Khorasan. First Symposium of Iranian Society of Economic Geology, Ferdowsi University of Mashhad, Mashhad, Iran. (in Persian with English abstract)
- Andrew, G.S.D., Cook, D. and Gemmel, J.B., 2008. Hydrothermal breccias and veins at the Kelian gold mine, Kalimantan, Indonesia: Genesis of a large epithermal gold deposit. *Economic Geology*, 103(4): 717–757.
- Arjmandzadeh, R., 2011. Mineralization, geochemistry, geochronology, and determination of tectonomagmatic setting of intrusive rocks in Dehsalm and Chahshaljami prospect areas, Lut Block, eastern Iran. Ph.D. thesis, Ferdowsi University of Mashhad, Mashhad, Iran, 215 pp. (in Persian)
- Karimpour, M.H., Malekzadeh Shafaroudi, A., Mazaheri, S.A. and Haidarian Shahri, M.H., 2007. Magmatism and different types of mineralization in Lut Block. 15<sup>th</sup> Symposium of Iranian Society of Crystallography and Mineralogy, Ferdowsi University of Mashhad, Mashhad, Iran. (in Persian with English abstract)
- Malekzadeh Shafaroudi, A., Karimpour, M.H. and Mazaheri, S.A., 2010. Rb-Sr and Sm-Nd isotopic composition and petrogenesis of ore-related intrusive rocks of gold-rich porphyry copper Maherabad prospect area (north of Hanich), east of Iran. *Iranian Journal of Crystallography and Mineralogy*, 18(2): 15–32. (in Persian with English abstract)
- Malekzadeh Shafaroudi, A., Karimpour, M.H. and Stern, C.R., 2015. The Khopik porphyry copper prospect, Lut Block, Eastern Iran. Geology, alteration and mineralization, fluid inclusion, and oxygen isotope studies. *Ore Geology Reviews*, 65(2): 522–544.
- Richards, J.P., Spell, T., Rameh, E., Razique, A. and Fletcher, T., 2012. High Sr/Y magmas reflect arc maturity, high magmatic water content, and porphyry Cu ± Mo ± Au potential: examples from the Tethyan arcs of central and eastern Iran and western Pakistan. *Economic Geology*, 107(2): 295–332.