Ore Geology Reviews 94 (2018) 277–289

Contents lists available at ScienceDirect

Ore Geology Reviews

journal homepage: www.elsevier.com/locate/oregeorev

Fluid inclusion and O–H–C isotopic constraints on the origin and evolution of ore-forming fluids of the Cenozoic volcanic-hosted Kuh-Pang copper deposit, Central Iran

Shahrokh Rajabpour[a,*], Shao-Yong Jiang[b,*], Bernd Lehmann[c], Ali Abedini[d], Daniel D. Gregory[e]

[a] Department of Geology, Faculty of Earth Science, Shahid Beheshti University, Tehran, Iran
[b] State Key Laboratory of Geological Processes and Mineral Resources, Collaborative Innovation Center for Exploration of Strategic Mineral Resources, Faculty of Earth Resources, China University of Geosciences, Wuhan 430074, China
[c] Mineral Resources, Technical University of Clausthal, 38678 Clausthal-Zellerfeld, Germany
[d] Geology Department, Faculty of Sciences, Urmia University, Urmia, Iran
[e] Department of Earth Sciences, University of California, Riverside, CA 92521, USA

ARTICLE INFO

Keywords:
Fluid inclusions
H–O–C isotopes
Epithermal
Kuh-Pang Cu deposit
Central Iran

ABSTRACT

The Kuh-Pang copper deposit (2.8 Mt @ 1.65% Cu, 0.52 g/t Au, 34 g/t Ag) is a volcanic-hosted epithermal deposit in the central part of the Late Eocene-Oligocene Urmia-Dokhtar Magmatic Arc of Iran. Three stages of fluid evolution are identified at the Kuh-Pang deposit: (i) early pre-ore stage: with homogenization temperature of 205–372 °C (298 ± 45 °C), salinity of 11.3 ± 2.9 wt% NaCl equiv., fluid trapped at ~200 bars, (ii) main-ore stage: with homogenization temperature of 175–310 °C (253 ± 43 °C), salinity of 2.1–12.5 wt% NaCl equiv. at ~150 bars, and (iii) late post-ore stage: with homogenization temperatures of 148 to 231 °C (199 ± 24 °C), and salinity of 1.1–9.8 wt% NaCl equiv. These data record an evolution of mineral precipitation from deeper (> 2 km) to shallower environments (< 500 m). Fluids trapped in the early (quartz I) and main-ore stages (quartz II) yielded $\delta^{18}O_{fluid}$ values of +5.7 to +5.9‰ and +3.2 to +3.8‰, and δD_{fluid} values of −77 to −41‰ and −84 to −60‰, respectively. These data indicate a major magmatic fluid source, with slightly increasing mixing of meteoric waters. Calcite in the late post-ore stage has $\delta^{13}C_{V-PDB}$ values of −5.8 to −5.6‰ and $\delta^{18}O_{V-SMOW}$ values of 8.2–8.6‰, with calculated $\delta^{18}O_{fluid}$ and $\delta^{13}C_{fluid}$ values of −1.0 to −1.4‰ and −5.4 to −5.2‰ respectively, that are also consistent with a predominantly magmatic carbon source and a significant fluid mixing by meteoric waters.

1. Introduction

The Saveh metallogenic domain (Fig. 1) is a constituent part of the NW–SE trending Urmia-Dokhtar Magmatic Arc (UDMA) in the Alpine-Himalayan orogenic belt. It is considered to be one of the most important mineralization belts in Iran, hosting numerous ore deposits, including major porphyry and epithermal Cu–(Ag–Au) deposits (e.g., Shahabpour and Kramers, 1987; Calagari, 2004; Shafiei et al., 2009; Boomeri et al., 2010; Aghazadeh et al., 2015). Volcanic-hosted epithermal deposits and skarn deposits have been reported mostly in or associated with Late Eocene volcanic rocks in the Alborz-Azerbaijan volcano-plutonic belt in the northern part of the UDMA (Shamanian et al., 2004; Richards et al., 2006; Baghban et al., 2015, 2016;Kouhestani et al., 2015;Mehrabi et al., 2016). Late Eocene volcanic rocks occur on the Lut Block in Eastern Iran (Shafaroudi and Karimpour, 2015) and in the Miocene Makran volcanic arc (Sholeh et al., 2016). On a global scale, volcanic-hosted epithermal base metal deposits are widely distributed in volcanic sequences, and are an economically important deposit type with variable amounts of Ag and Au as by-products (Sillitoe, 1989; Hedenquist and Garcia, 1990; Vennemann et al., 1993; Moritz et al., 2004; Bethke et al., 2005; Esteban-Arispe et al., 2016).

Eocene-Oligocene volcanic units in the Markazi province of northwestern Iran, about 120 km SW of Tehran, host several Cu deposits and occurrences, which define a regional NW-trending belt of volcanic-hosted epithermal Cu deposits, extending for almost 30 km from the Kuh-Pang village in the southeast to Malek Abad in the northwest (Fig. 1). There are a number of studies on the Saveh region (e.g. Caillat et al., 1978; Davarpanah, 2009; Rezaei-Kahkhaei et al., 2011), most of which focused on petrography and petrochemistry of the igneous rocks.

* Corresponding authors.
E-mail addresses: sh.rajabpour@gmail.com (S. Rajabpour), shyjiang@cug.edu.cn (S.-Y. Jiang).

https://doi.org/10.1016/j.oregeorev.2018.02.003
Received 21 October 2017; Received in revised form 23 January 2018; Accepted 2 February 2018
Available online 03 February 2018
0169-1368/

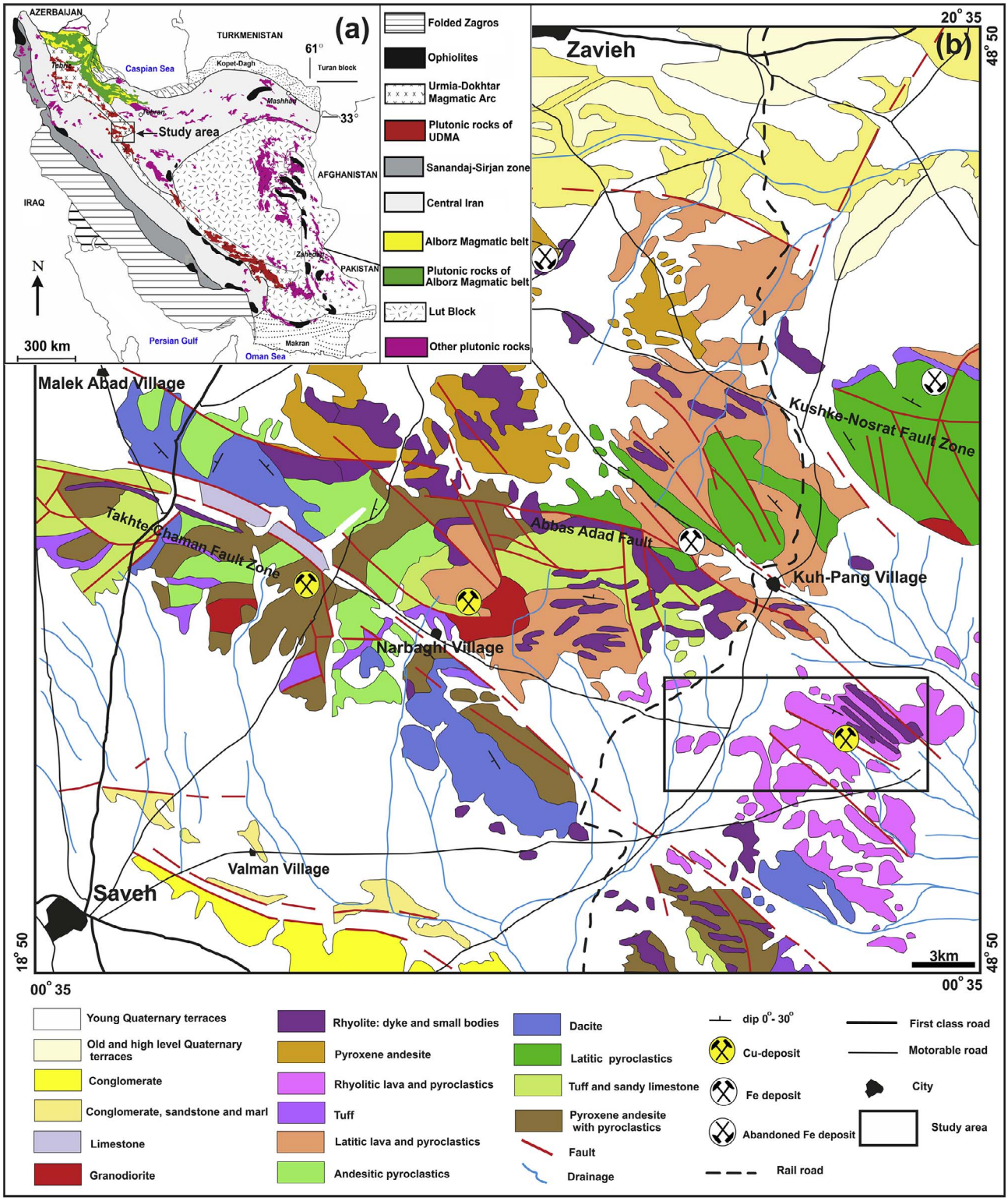

Fig. 1. (a) Schematic geological map of Iran, showing the distribution of the major sedimentary and structural units (after Aghanabati, 1998) and igneous rocks (after Aghanabati, 1991). The Urmia–Dokhtar magmatic arc (UDMA) is mostly of Eocene-Miocene age. The location of the study area is indicated in the map; (b) Location of the Kuh-Pang Cu deposit and other Cu and Fe deposits within a simplified regional geologic map of NE Saveh and prospects of the major metallogenic belt within this zone (modified from Amidi et al., 2006 and presented in Rajabpour et al., 2017).

The Kuh-Pang Cu deposit (50°42′E, 35°06′N) in the middle part of the UDMA is situated about 40 km ENE of Saveh, Markazi Province (Fig. 1a), and was discovered by National Iranian Copper Industries Co. (NICICO) in 2006. Since then, it has been the highest grade Cu deposit mined in the UDMA, with measured resources of 2.8 Mt at 1.65% Cu, 0.52 g/t Au, 34 g/t Ag. The copper mineralization occurs within veins hosted in an approximately 400-m-thick package of Eocene-Oligocene altered rhyodacitic and andesitic rocks and has features of volcanic-hosted epithermal deposits (Samani, 1998, 2003; Rajabpour et al., 2015). These features include type of host rocks, mineralization styles,