Journal of African Earth Sciences 116 (2016) 160–169

Contents lists available at ScienceDirect

Journal of African Earth Sciences

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

The origin of the mineralizing fluids in different type mineralizations associated with the Upper Cretaceous Elazig Magmatic Complex, Turkey; an isotopic approach

Muharrem Akgul*

Firat University, Department of Geological Engineering, 23119, Elazig, Turkey

ARTICLE INFO

Article history:
Received 27 November 2015
Received in revised form
27 December 2015
Accepted 28 December 2015
Available online 5 January 2016

Keywords:
Elazig Magmatic Complex
Eastern Taurid
Mineralization
Stable isotopes
Turkey

ABSTRACT

This study examined the origin and properties of mineralized fluids by using C, O and S isotopes in different type mineralizations associated with the Upper Cretaceous Elazig Magmatic Complex. The isotopic compositions of vein type mineralizations show that the thrust zone affects the formation of the Karakas iron mineralization by meteoric and magmatic hydrothermal solution mixtures due to the average $\delta^{18}O_{H2O}$ value 6.40‰. The calculated $\delta^{18}O_{H2O}$ composition values is 5.20‰ in biotite from the Kızıldag vein type Cu–Pb–Zn mineralizations, which is consistent with a magmatic origin of the fluids. The calculated $\delta^{18}O_{H2O}$ composition is 4.30‰ that indicates a medium and low temperature magmatic hydrothermal fluid effect. The skarn type mineralizations isotopic compositions indicate that the calculated $\delta^{13}C_{CO2}$ values are between −12.70‰ and −36.39‰ that could be late magmatic fluids that were modified by interaction with the host meta-sedimentary rocks and with meteoric water at the Birvan and Asvan iron mineralizations. Also the $\delta^{18}O_{H2O}$values in quartz of the Meseli iron mineralization are between 0.70‰ and 1.30‰. The lower $\delta^{18}O_{H2O}$ oxygen isotope composition compared to magmatic origins must be hydrothermal solutions mixing with meteoric waters. In the massive sulfide type Kavallı and Derince pyrite samples, $\delta^{34}S_{H2S}$ values are between 17.73‰ and 20.63‰. These values clearly indicate the volcano-sedimentary effect on hydrothermal solutions, which form the mineralization. The first findings of this study present information that all of the measured isotopic composition was modified by mixing metamorphic, magmatic and meteoric waters in the final stages of the hydrothermal solutions circulation.

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1. Introduction

This paper includes in investigations of the stable isotopes of the mineralizations from different origins associated with the Elazig Magmatic Complex (Upper Cretaceous) in the Eastern Anatolia Region. The study area is located in the East Taurus orogenic zone (Fig. 1). This unit consists of plutonic and volcanic rocks of ranging composition from diorite to granite, basaltic lava flow, pillow lava, andesitic lava and pyroclastic and dacitic lava flow, and observed large outcrops in the Elazig region. Turan et al. (1993) indicated that this complex occurred at the end of development of an island arc. In addition, there are numerous mineralizations, economic or non-economic, associated with the Elazig Magmatic Complex. The some of the mineralizations occur along the fissures and faults within breccia zones. The others form along to intrusive zones (Fig. 1). It is possible to come across mineralizations from different origins in pillow lavas in the east of the study area. This study presents data on the geology, stable isotopes of the mineralizations in the eight different locations and three different groups according to their origins; vein type, pyro-metasomatic (skarn) type and massive sulfide type. Kızıldag (Harput) Cu–Pb–Zn mineralizations (Sagiroglu, 1986; Sasmaz and Sagiroglu, 1990, 1999; Sagiroglu and Sasmaz, 2004); Karakas (Baskil) Fe mineralizations (Akgül and Acar, 1997) and Cu mineralizations based on quartz veins (Baskil) are vein type mineralizations (Akgül et al., 2003). Birvan (Elazig) Fe–Ti mineralizations, Meseli (Elazig) Fe mineralizations and Asvan (Elazig) mineralizations are pyro-metasomatic mineralizations (Akgül and Sasmaz, 1996). Kavalli (Sivrice-Elazig) Cu mineralizations (Suiçmez and Bölücek, 1998) and Derince (Keban-Elazig) Cu mineralizations are massive sulfide mineralizations (Bölücek et al.,

* Tel.: +90 424 2370000; fax: +90 424 2411226.
E-mail address: makgul@firat.edu.tr.

http://dx.doi.org/10.1016/j.jafrearsci.2015.12.027
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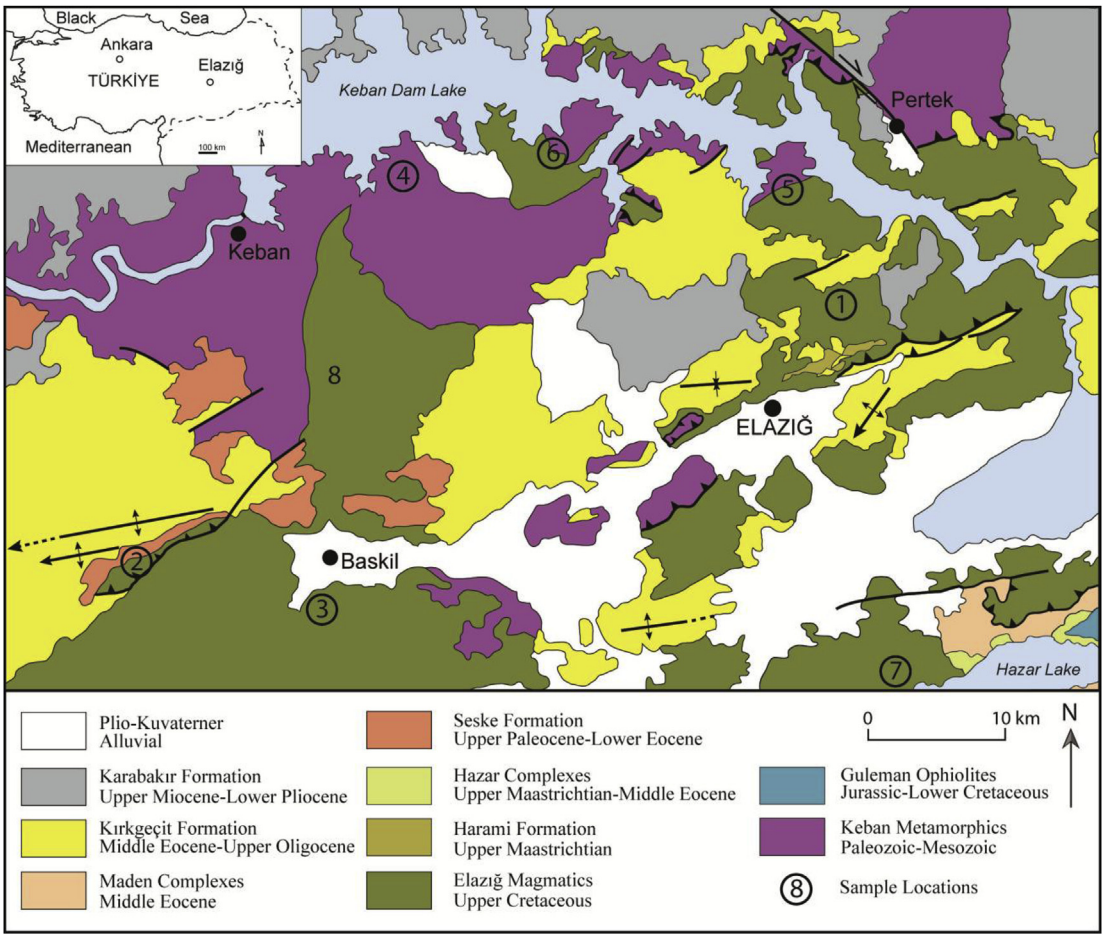

Fig. 1. Location and geological map of the study area (Turan and Bingol, 1991).

2001). Previous studies indicated that all of these mineralizations occurred in different temperature and compositions by the different hydrothermal solutions but there is no information on the isotopic studies of these mineralizations in the study area. The principal aims of the study are to determine the origin of the ore-forming fluids, and to elucidate the genesis of the deposit by using C, O and S isotopes.

2. Geological setting

The lithological units from bottom to top in the study area are shown on Fig 1. The Keban Metamorphites consist of the units as recrystallized limestone, calcschist, meta-conglomerate and calc-phyllite (Kipman, 1976). The unit was exposed to regional metamorphism in relation to the geotectonic development of the region at the end of the Late Cretaceous (Kipman, 1981). The Keban Metamorphites outcrop in the west of the Birvan town and to the north of the Baskil town. The oldest units of the study area are the Keban Metamorphites (Lower Triassic). They consist of recrystallized limestone, calc-schist and meta-conglomerates. This unit's recrystallized limestone outcrop around Karakas, Birvan and Asvan (Fig. 1).

The Elazig Magmatics are the most common litho-stratigraphic units in the region (Fig. 1). They were named the Yüksekova Complex around Hakkari for the first time by Perinçek (1979a). Yazgan (1984) and Akgül (1993) both used the same nomenclature for the unit. However, Turan et al. (1993) emphasized that the unit should be assessed differently from the Yüksekova Complex because it bears different lithological features around Elazig and does not show complex features but regular hoarding from bottom to top. Neutral plutonic rocks with silica-saturated intermediate composition such as gabbro, diabase, diorite and monzonite constitute the lower levels of the unit, pillow lava structured basaltic lava flows and basalt and andesite and andesitic pyroclastics along with the layer volcano-sedimentaries constitute the upper levels of the unit. It is seen that tonalite, granodiorite and dacite cut these units. It has been stated that Upper Cretaceous magmatic rocks are related to arc magmatism (Asutay, 1985; Akgül, 1993; Bingöl and Beyarslan, 1996). By using the regional outcrop data along with the major and trace element data, Akgül et al. (2010) indicated that the magmatics related to supra-subduction arc materials developed partly on oceanic and continental crusts. The same researchers stated that the plutonic rock samples within the study area belong to a subalkaline series and in the AFM triangular diagram, gabbro/diorite composite rocks offer a distribution both in toleitic and calc-alkaline areas. In contrast, it is stated that the rocks with granitic composition are involved in calc-alkaline areas and fall into the category of I-type granodiorites. In a comprehensive study conducted in the region, it is emphasized that the plutonic rocks are originally the same, and probably formed by fractional crystallization from the same magma. In the K–Ar age determinations practiced on biotite and hornblends at different plutons belonging to the Elazig Magmatics, it is determined that the cooling age of granodiorites range between 72.2 ± 2.7 and 84.1 ± 3.2 Ma, while granites range between 80.5 ± 3.8 Ma (Akgül et al., 2010). Tectonic and intrusive contacts in patches and mineralizations related to these are seen between the Keban

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