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Mineralogic, fluid inclusion, and sulfur isotope evidence for the genesis of Sechangi lead–zinc (–copper) deposit, Eastern Iran

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ABSTRACT

The Sechangi lead–zinc (–copper) deposit lies in the Lut block metallogenic province of Eastern Iran. This deposit consists of ore-bearing vein emplaced along fault zone and hosted by Late Eocene monzonite porphyry. Hydrothermal alteration minerals developed in the wall rock include quartz, kaolinite, illite, and calcite. Microscopic studies reveal that the vein contains galena and sphalerite with minor chalcopyrite and pyrite as hypogene minerals and cerussite, anglesite, covellite, malachite, hematite, and goethite as secondary minerals. Fluorite and quartz are the dominant gangue minerals and show a close relationship with sulfide mineralization. Calculated $\delta^{34}S$ values for the ore fluid vary between −9.9‰ and −5.9‰. Sulfur isotopic compositions suggest that the ore-forming aqueous solutions were derived from magmatic source and mixed with isotopically light sulfur, probably leached from the volcanic and plutonic country rocks. Microthermometric study of fluid inclusions indicates homogenization temperatures of 151–352 °C. Salinities of ore-forming fluids ranged from 0.2 to 16.5 wt.% NaCl equivalent. The ore-forming fluids of the Sechangi deposit are medium- to low-temperature and salinity. Fluid mixing may have played an important role during Pb–Zn (–Cu) mineralization. The key factors allowing for metal transport and precipitation during ore formation include the sourcing of magmatic fluids with high contents of metallogenic elements and the mixing of these hydrothermal fluids with meteoric waters resulting in the formation of deposit. In terms of the genetic type of deposit, the Sechangi is classified as a volcanic–subvolcanic hydrothermal-related vein deposit.

1. Introduction

Cenozoic magmatic rocks in Iran are distributed mostly in four belts (Fig. 1A). The Urumieh-Dokhtar magmatic arc extends for over 1700 km in the NW–SE direction, which includes world-class porphyry copper deposits such as Sarcheshmeh and Miduk (Waterman and Hamilton, 1975; Forster, 1978; Berberian et al., 1982; Mohajjel et al., 2003; Shahabpour, 2005, 2007; Ghasemi and Talbot, 2006; Shafiei et al., 2009; Boomeri et al., 2009). The Alborz-Azarbaijan magmatic belt, in the north, extends for 800 km, varying between NW–SE and W–E directions (Nabavi, 1976); the western end of this belt merges into the Urumieh-Dokhtar belt (Fig. 1A). The west of the belt, known as Arasbaran metallogenic zone, hosts the world-class Sungun porphyry Cu–Mo deposit (Calagari et al., 2001; Calagari, 2003), Anjerd, Sungun, and Mazraeh Cu skarn deposits (Karimzadeh Somarin and Hosseinzadeh, 2002; Karimzadeh Somarin, 2004), and several epithermal style gold occurrences. Hassanzadeh et al. (2002) presented evidence for an intra-arc rifting in Urumieh-Dokhtar magmatic belt during Oligocene–Miocene, leading to the separation and northward movement of what is now known as Alborz-Azarbaijan magmatic belt (Fig. 1A). The Khaf-Kashmar-Bardaskan magmatic belt crosses NE Iran (Fig. 1A), which has significant potential for iron oxide type mineralization, including iron-oxide copper–gold (IOCG) and magnetite deposits, such as Kuh-e-Zar, Shahrak, Tannurjeh, and Sangan (Karimpour, 2004; Mazloumi et al., 2009; Yousefi et al., 2009). The east-trending, ~50 km wide belt extends ~400 km along the north side of the Duroneh Fault (Malekzadeh Shafaroudi et al., 2013a). The Eastern Iran belt extends for 1000 km in the N–S direction, within the Lut block (Fig. 1A). This block is bounded to the east by the Nehbandan and associated faults, to the north by the Doruneh and related faults (Sabzevar zone), and to the west by the Nayband Fault (Fig. 1A and B). The Lut block is the main metallogenic province in east of Iran (Karimpour et al., 2012) that comprises numerous porphyry Cu and Cu–Au deposits, low and high sulfidation epithermal Au deposits, and Cu–Pb–Zn vein-type

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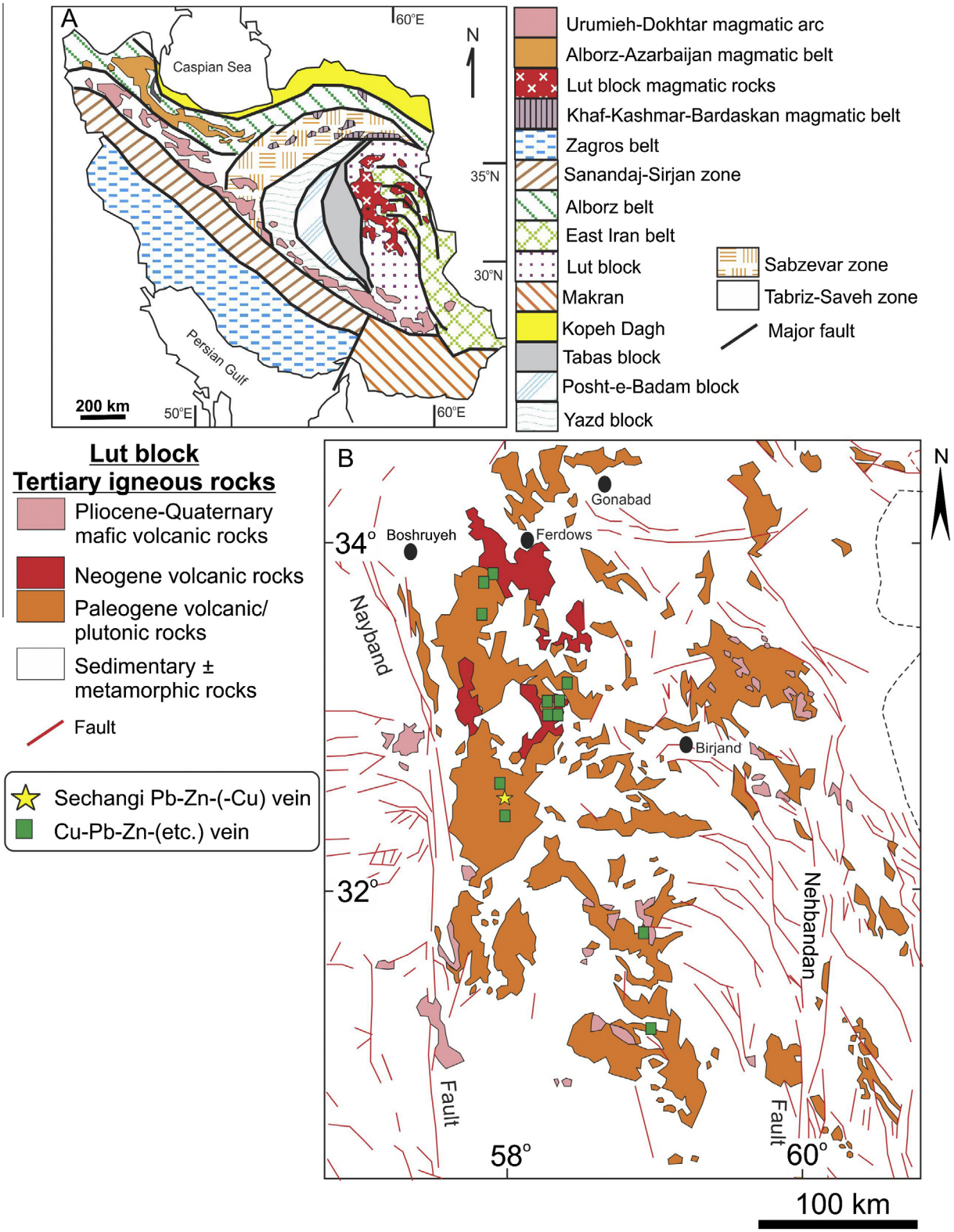

Fig. 1. A. A simplified map showing the main geological divisions, and the distribution of the Cenozoic magmatic assemblages, in Iran (after Stocklin, 1968; Alavi, 1996). B. Tertiary igneous rocks of the Lut block, Eastern Iran, showing the locations of Sechangi and some base metal vein-type deposits. Based on maps from the Geological Survey of Iran (1989, 2009, and various 1:250,000-series maps).

deposits (Malekzadeh Shafaroudi, 2009; Arjmandzadeh et al., 2011; Karimpour et al., 2012; Richards et al., 2012; Malekzadeh Shafaroudi and Karimpour, 2013a). Karimpour et al. (2012) studied the relationship of Rb–Sr isotope, geochemistry, and age data of Tertiary granitoid rocks (syn-mineralization units) with different types of mineralization in the Lut block. They concluded that the age of these intrusions is between middle Eocene to lower Oligocene (43.3–33.3 Ma.). In addition, the initial $^{87}Sr/^{86}Sr$ ratios