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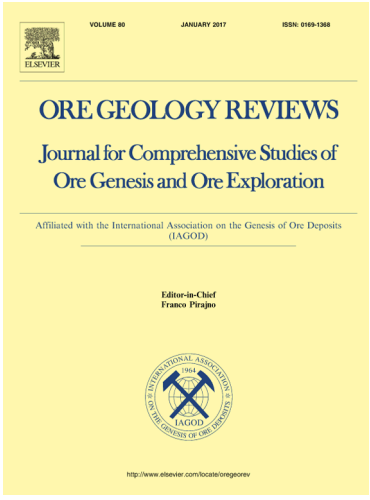

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Mostafa Nejadhadad, Batoul Taghipour, David Lentz

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Geochemical, isotopic, and fluid inclusion signatures of Zn-Pb mineralization in the Tiran mining district, Isfahan, Sanandaj-Sirjan zone (Iran)

Mostafa Nejadhadad[a], Batoul Taghipour[a, *], David Lentz[b]

[a]Department of Earth Sciences, Faculty of Sciences, Shiraz University, Shiraz, Iran

[b]Department of Earth Sciences, University of New Brunswick, Fredericton, NB E3B 5A3, Canada

*Corresponding author. *E-mail:* taghipour@shirazu.ac.ir; tel: +98 91 7409 1677

Abstract

In Tiran base-metal district, the post-Early Cretaceous epigenetic Zn-Pb deposits occur as fault-controlled pocket-like lenses. The main structural feature of mineralization is its association with district-scale strike-slip faults, which cuts an en-echelon folded terrane. Mineralization occurs as sphalerite, galena, pyrite, and minor chalcopyrite found within massive ore, breccia textures, veins and veinlets, disseminated grains and carbonate replacements along tectonized limestone-shale contacts. The cumulative reserves of this district is 10 Mt grading at 6% Zn+Pb. Host rock silicification and calcitization formed during hydrothermal alteration. Fluid inclusion data revealed that ore minerals precipitated due to the mixing of two fluids, one determined from sphalerite-hosted inclusions (Homogenization temperature: 155 ˚C and salinity: 19 wt% $NaCl_{equiv.}$) and the other observed in quartz inclusions (Th: 184.5 ˚C and salinity: 12.5 wt% $NaCl_{equiv.}$). The sulfur isotope compositions of sulfide minerals vary between -8.92 and +4.15 ‰ and ranged from 22.61 to 23.88 ‰ for barite, thus suggesting an Early Tertiary marine sulfate influence. Sulfur isotopic data favor two sources of sulfur: bacteriogenic activity ($\delta^{34}S_{CDT}$ -9 to -6 ‰) and thermochemical sulfate reduction ($\delta^{34}S$: -1 to +4 ‰). The $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, and $^{208}Pb/^{204}Pb$ ratios (18.1 to 18.4, 15.6 to 15.7, and 38.4 to 38.6, respectively) reflect upper crustal basement rocks as the source of metals. Fertile ore fluids mixed within fault zones, along the contacts of limestone and shale. Base metal deposition during fluid mixing could be a result of increasing reduced sulfur, cooling, and decreasing ligand activity after tectonic movements. The multiple lines of evidence presented here are consistent with the mineralization in the Tiran mining district being similar to Mississippi Valley-type deposits.

Keywords: fluid mixing, sulfur isotopes, lead isotopes, fault-controlled Zn-Pb mineralization, Tiran mining district

1. Introduction

The Isfahan-Malayer Pb-Zn belt has been documented by Ziserman and Momenzadeh (1972), Momenzadeh and Rastad (1973), Förster (1978), and most recently Rajabi et al. (2012). This Cretaceous carbonate platform (McQuarrie et al., 2003; Alavi, 2004; Golonka, 2004; Ghasemi and Talbot, 2006; Seton et al., 2012) is host to more than 250 ore deposits and prospects (Ghorbani, 2013). These deposits are mainly strata-bound and, in most cases, show discordant features with the enclosing strata. They have facies transitions between the shale and carbonate, but have no obvious genetic relation with igneous rocks (Momenzadeh, 1976; Förster, 1974, 1978; Momenzadeh et al., 1979; Rastad et al., 1980; Ghazban et al., 1994; Ehya et al., 2010; Rajabi et al., 2012; Nejadhadad et al., 2015; Hosseini-Dinani and Aftabi, 2016). Previous work has documented the geological and mineralogical characteristics of some deposits, e.g., Ahangaran (Momenzadeh, 1976; Momenzadeh et al., 1979), Irankuh (Rastad et al., 1980), Ravanj, and Tiran (Rajabi et al., 2012), that favour an