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Effects of host rock mineralogical composition and sedimentary facies on development of geochemical halos in Shahmirzad Pb–Zn deposits, central Alborz, Iran

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ABSTRACT

Strata-bound carbonate hosted Pb–Zn deposits or Mississippi Valley-type (MVT) deposits represent an economically important class of ore that received much attention in terms of defining effects of host rock petrography and sedimentary facies on development of geochemical halos. However there are few works on relation between sedimentary facies and MVT mineralizations in Iran. The Cretaceous carbonate rocks in the central Alborz (CA), northern Iran, host numerous small Pb–Zn deposits and occurrences. The Shahmirzad Pb–Zn deposits, located in the south of CA, geographically can be split into two groups, the north east (NEDs) and north west (NWDs) deposits. The Upper Cretaceous sequence in the NWDs area is composed of massive light gray limestone without any signs of later changes such as dolomitization and silicification. Additionally, three principal micro-facies are present: skeletal mudstone/wackestone (F1), biolithoclastic packstone (F2) and allochthonous bioclastic floutstone (F3). In contrast, the Cretaceous sequence hosting the NEDs is composed of massive brown limestone with six different types of dolomite (Rd1, Rd2, Rd3, Rd4, Cd1 and Cd2, the two last types are related to ore mineralization and open space filling) distinguished based on crystal size, distribution, and crystal boundary shape. The sedimentary succession in the NEDs indicates that the sedimentation took place in inner, mid and outer ramp environments, resulting in three different carbonate facies. In this area 15 carbonate facies were identified. The permeability and mineral compositions of these areas have obviously influenced the quantity of major and minor elements such as Fe (in average 0.24% in the NWDs and 0.12% in the NEDs), Si (in average 1.86% in the NWDs and 0.44% in the NEDs), Al (in average 0.50% in the NWDs and 0.13% in the NEDs), K (in average 0.24% in the NWDs and 0.06% in the NEDs), Sr (in average 685 ppm in the NWDs and 204 ppm in the NEDs), Na (in average 0.03% in the NWDs and 0.01% in the NEDs), Zn (in average 46 ppm in the NWDs and 188 ppm in the NEDs) and Pb (in average 3.3 ppm in the NWDs and 83 ppm in the NEDs). Not only are minor and major elements affected by changes in host rock mineral composition, but REEs decreased in concentration in dolomitic host rocks of NEDs. Some of the noticeable differences between the NWDs and the NEDs REEs data are i.e. La (in average 3.52 ppm in the NWDs and 1.47 ppm in the NEDs), Ce (in average 5.20 ppm in the NWDs and 2.21 ppm in the NEDs) and Eu (in average 0.13 ppm in the NWDs and 0.03 ppm in the NEDs). The combination of these data and host rock characteristics indicate that host rock compositions and textures effectively controlled these variations. We believe that perhaps the lack of dolomitization and low permeable facies in the NWDs precluded migration of diagenetic fluids and hydrothermal solutions in the carbonate host rocks. On the other hand, the presence of broad dolomitization and permeable facies in the NEDs carbonate host rocks may create appropriate conditions for diagenetic and hydrothermal fluid migration and interaction with the host rocks.

1. Introduction

The mineralogical nature of host rocks has an important role in the migration and geochemical activation of ore fluids in strata-bound carbonate hosted Pb–Zn deposits (e.g., Leach et al., 2005; Ruffell et al., 1998; Vandeginste et al., 2007). The permeability of the host succession permits the ore fluids to migrate into the host rock and to develop geochemical halos (Large et al., 2001; Swennen and Viaene, 1990). In carbonate series, dolomitization and porous sedimentary facies are two crucial items which control the permeability and porosity of carbonate rocks (Swennen and Viaene, 1990). Hence we have investigated the effects of host rock composition and textures on development of geochemical halos in the study area.

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More than 600 Zn–Pb deposits and occurrences have been recognized in Iran. The most important metallogenic provinces for Pb–Zn mineralization are the Sanandaj–Sirjan Zone (SSZ), the Central Iran Zone (CIZ), and the Alborz Zone (AZ), (Fig. 1a). According to Reichert (2007) the ages of the mineralization events and host rocks range from the Upper Proterozoic (e.g. the Milakuh–Touyeh F(Zn, Pb, Ba) deposit: Rastad et al., 2002) to Oligocene–Miocene. However most of the host rocks are either Paleozoic or Cretaceous carbonate rocks (Reichert, 2007).

Cretaceous carbonate rocks have a major role in the occurrences of Pb-Zn mineralization in Iran, such as Mehdiabad (218 Mt at 7.2% Zn, 2.3% Pb, 51 g/t Ag: Hitzman et al., 2003), Iran–Kuh (15 Mt at 4% Zn, 2% Pb: Hitzman et al., 2003) and Emarat (10 Mt at 6% Zn, 2.26% Pb: Ehya et al., 2010) deposits. Carbonate rocks of this age in CA host plenty of small Pb-Zn deposits and other mineral occurrences. The Shahmirzad Pb–Zn deposits are among those deposits and are located in the south of CA (Fig. 1a). In the Shahmirzad region, deposits are located in the North East (herein after NEDs) and North West (herein after NWDs) of the region. Mining of these deposits began in 1974 and continued for a period of 15 years, and now they are abandoned mines. Reza Abad is the largest deposit (Fig. 1b) with more than 0.2mt reserve at 8.0% Pb and 0.8% Zn grade.

Although there are a few studies of facies changes and its relationship with mineralization on the NWDs (i.e. Bazargani-Guilani et al., 2010b; Rabeie, 2007, 2008), most of the investigations on the NEDs have focused on the Cretaceous carbonate facies and dolomitization (Bazargani-Guilani and Faramarzi, 2005, 2007, 2008; Bazargani-Guilani and Rabeie, 2008; Bazargani-Guilani et al., 2010a). The aims of this study are to investigate the trends and effects that host carbonate and sedimentary facies have on dispersion of the geochemical halo in the NWDs and the NEDs and to show sedimentary and diagenetic processes control the formation of the strata-bound carbonate hosted Pb–Zn mineralization.

2. Material and methods

Representative geochemical samples were collected along stratigraphic profiles across the host rocks and ore zones near the abandoned mines, perpendicular to bedding. Detailed petrographic studies were conducted on hand specimens, thin and polish sections.

Petrographic studies of samples, were carried out using a Zeiss Axioplan 2 polarized light microscope after staining with Alizarin Red-S and potassium ferricyanide (Dickson, 1965) in order to distinguish calcite from dolomite and ferrous from non-ferrous calcite. Eighteen selected samples were subjected to X-ray diffraction analysis in the School of Geology, University of Tehran, using a D4 Bruker XRD. All measurements were run in a backpacked sample container that held ~1 g of sample mixed with a quartz standard. In addition to microscopic investigations, some samples were analyzed by ICP-MS and ICP-ES for major and minor elements and REEs of the Acme laboratory, Vancouver, Canada and at the Technical University of Clausthal, Germany (Tables 2, 3 and 4).

3. Regional geology

The Alborz Zone (AZ), northern Iran, is considered as a collisional structure (Alavi, 1996; Guest et al., 2006; Horton et al., 2008; Vernant et al., 2004). The AZ was deformed by strain partitioning of oblique shortening onto mountain range-parallel left-lateral strike-slip and

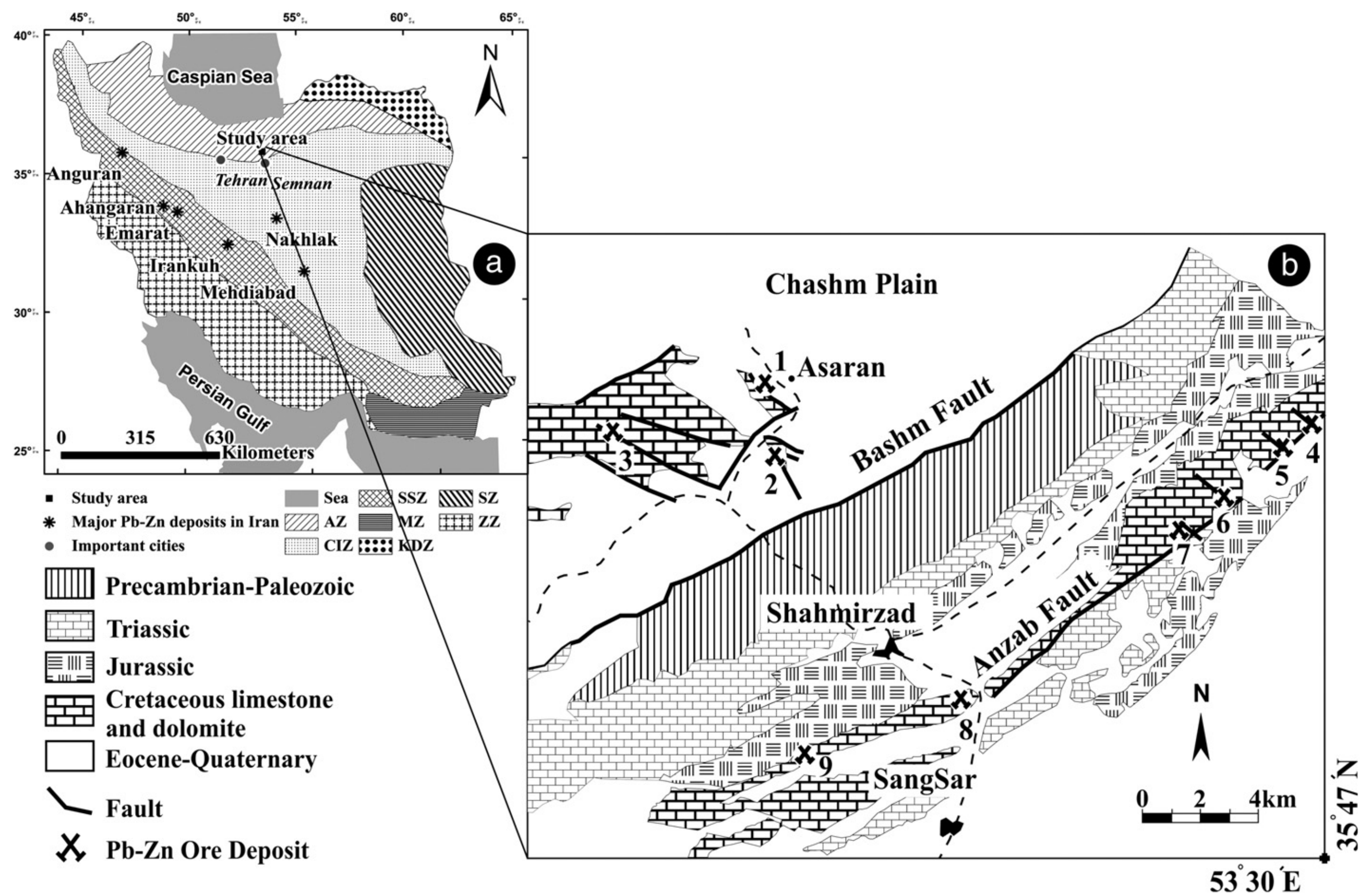

Fig. 1. a) General tectonic map of Iran (Simplified from tectonic map of Iran, Geological Survey of Iran, Nabavi, 1976); Alborz Zone (AZ), Central Iran Zone (CIZ), Kopeh–Dagh Zone (KDZ), Makran Zone (MZ), Sanandaj–Sirjan Zone (SSZ), Sistan Zone (SZ), Zagros Zone (ZZ). The study area is situated in the Alborz Zone. b) Simplified geological map of the study area and location of nine Pb–Zn deposits; 1: Asaran, 2: Eram–Koochak, 3: Eram-Bozorg, 4: Reza–Abad, 5: Bozmolla, 6: Heydar–Abad, 7: Reza–Barak, 8: Darband, 9: Lave–Dar. There are three ore deposits in NWDs which are compared with three from six ore deposits in NEDs.