



The Angouran Zn (Pb) deposit, NW Iran: Evidence for a two stage, hypogene zinc sulfide–zinc carbonate mineralization

Farahnaz Daliran^{a,*}, Ken Pride^b, Johannes Walther^a, Zsolt A. Berner^a, Ronald J. Bakker^c

^a Institute for Applied Geosciences, Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany

^b Pro Geo Consultants, Calgary, AB, Canada

^c Resource-Mineralogy, Montanuniversität Leoben, 8700 Leoben, Austria

ARTICLE INFO

Article history:

Received 21 May 2012

Received in revised form 23 January 2013

Accepted 1 February 2013

Available online 10 February 2013

Keywords:

Angouran

Volcanic–hydrothermal

Quartz–sericite–dolomite alteration

Sphalerite

Galena

Barite

Hypogene smithsonite

Arsenopyrite

ABSTRACT

The unusually high grade hypogene zinc ore at Angouran in northwestern Iran (40.4% Zn, 1.9% Pb in the sulfide ore, 28.1% Zn, 4.4% Pb in the carbonate ore, and 110 g/t Ag) formed from an initially highly saline, reduced, relatively acid hydrothermal brine at two successive sulfide and carbonate ore stages. The early ore stage consists of multiple phases of sphalerite dominated sulfide ore breccia with subordinate amounts of galena (\pm Pb sulfosalts), minor pyrite, and abundant barite. Sphalerite precipitated at moderate temperatures (≥ 155 °C) because of pH increase in the presence of hangingwall marble. Smithsonite precipitated at a higher pH value (≥ 7) and at lower temperatures (≤ 120 °C) from dilute solutions (salinities close to zero) by mixing of the Zn bearing brines with cool, HCO_3^- bearing waters. The first melting points of the primary (LV) fluid inclusions in sphalerite and in hydrothermal quartz are unusually low (≤ -60 °C), close to the eutectic point of the ZnCl_2 – H_2O system (-62 °C). Total salinities taken from the ZnCl_2 – H_2O system as a best approximation correspond to 26–41 eq mass % ZnCl_2 . The initial brine evolved to a CaCl_2 – NaCl rich solution with 27 eq mass % salinity. Gas densities (≤ 0.1 g cm^{-3} for water vapor and ≤ 0.18 g cm^{-3} for CO_2) in the fluid inclusions indicate low pressure (≤ 5 bar for water vapor, and ≤ 100 bar for CO_2) at the entrapment temperatures. At the first carbonate ore stage sulfides continued to precipitate characteristically as arsenopyrite with minor amounts of galena and pyrite. The abrupt change of the fluid composition at the sulfide–carbonate boundary was accompanied by a change of the fluid temperature and pressure that produced brecciation of the sulfide ore matrix and an almost total dissolution of barite and replacement by the hypogene smithsonite. Alteration is restricted to ore deposition and consists of weak sericitization and silicification with local dolomitization at the sulfide ore stage, and pervasive dissolution of the hangingwall marble, in particular at the carbonate ore stage. The breccia orebody at Angouran is sited at the crestal portion of a domed antiform at the lithological and thrust boundary of Neoproterozoic–Lower Cambrian footwall schists and the hangingwall marble in rapidly uplifted and exhumated Angouran Block east of the Geynardjeh Thrust Fault. The footwall schists occupy a detachment fault zone above imbricated nappe sheets of the basement metamorphic complex of the Sanandaj–Sirjan zone. During the Pliocene, the nappe sheets were thrust toward the southwest onto the Miocene felsic volcanic rocks of the Urumieh Dokhtar Volcanic Belt that are intruded by 10 Ma late Miocene basalts. The 11.9 Ma and 18.4 Ma zircon ages of the felsic volcanic rocks indicate the lower age limit of the ore body emplacement. The associations with large scale, mid-late Miocene, felsic volcanism along the active Tethyan belt, as well as the ubiquitous presence of the volcanic rock clasts in the sphalerite ore matrix, provide strong evidence of the involvement of hydrothermal processes at Angouran. Ore fluids were successively and pulsatorily generated within the seismically active region. A following geothermal activity appears to have had a significant input in the formation of the carbonate ore of the hypogene, as well as the supergene stage. Stable isotope data suggest complex interaction of element sources and processes. Allowing a broad interpretation, the sulfur isotopic composition of the sulfides ($\delta^{34}\text{S}$: 3.9 to 7.4‰) suggests that the sulfur could be sourced from evolving, mixed magmatic–basinal brine. The isotopic composition of the hypogene smithsonites ($\delta^{13}\text{C}$: 2.72 to 5.51‰, $\delta^{18}\text{O}$: 18.4 to 22.8‰) broadly supports the local geology and field relationships, which comply with a marble wallrock source for the carbonate ores. They lend support to the assumption that smithsonite was deposited from solutions with isotopic composition similar to those involved in the hydrothermal dolomitization of the marbles. The excess of dissolved marble precipitated as large volumes of travertine and as late calcite veins ($\delta^{13}\text{C}$: 18.8 to 20.3‰, $\delta^{18}\text{O}$: 3.1 to 6.4‰) at the mineralization site. Isotope values of the travertine ($\delta^{13}\text{C}$: 4.5 to 6.6‰, $\delta^{18}\text{O}$: 20.1 to 21.1‰ V-SMOW) are consistent with the involvement of CO_2 derived

* Corresponding author. Tel.: +49 72160848109.

E-mail address: farahnaz.daliran@kit.edu (F. Daliran).

from thermogenic decarbonization of the host marble by waters of dominantly meteoric origin, most likely concomitantly with ore forming processes.

The Angouran deposit is the only reported case of a two stage, hypogene zinc sulfide–zinc carbonate mineralization, and represents a new style of nonsulfide zinc mineralization.

© 2013 Elsevier B.V. All rights reserved.

1. Introduction

Iran hosts many nonsulfide Zn occurrences and showings including the important Mehdi Abad and Iran (Shah) Kuh Zn carbonate

deposits postulated to be of supergene origin. These deposits are largely concentrated within the high plateau of the overriding Iranian Plate in a supra-subduction setting (Fig. 1a). The Angouran deposit is located in the province of Zandjan, 460 km west of Tehran, within

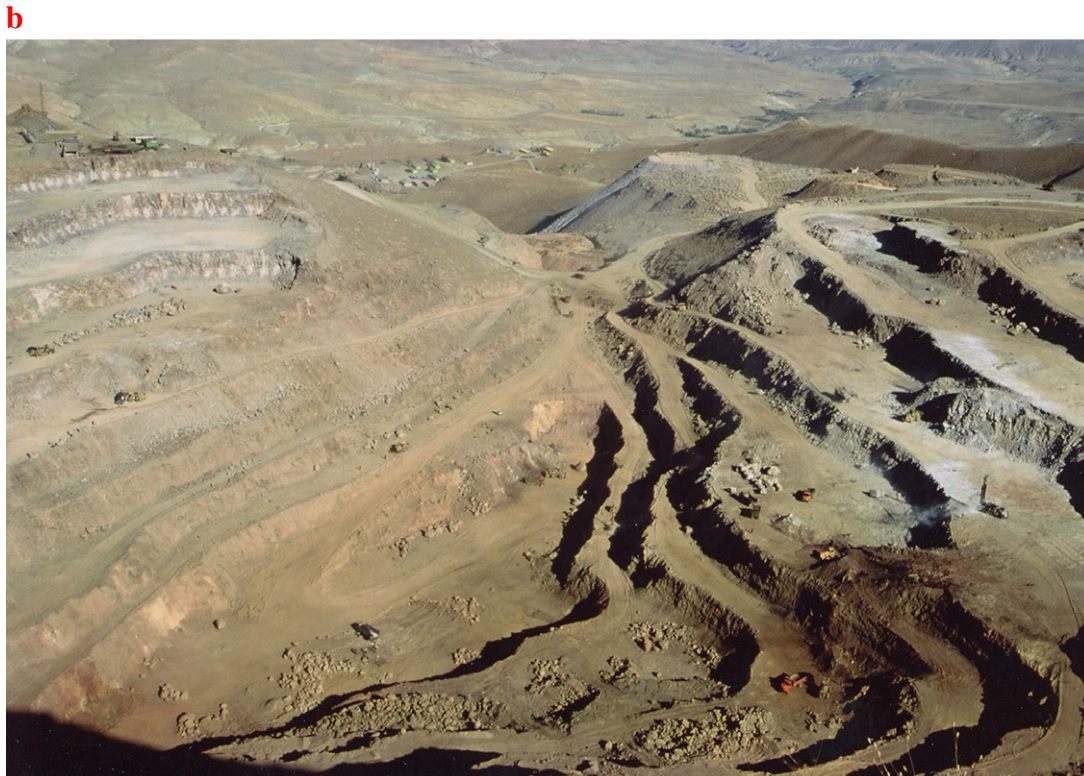
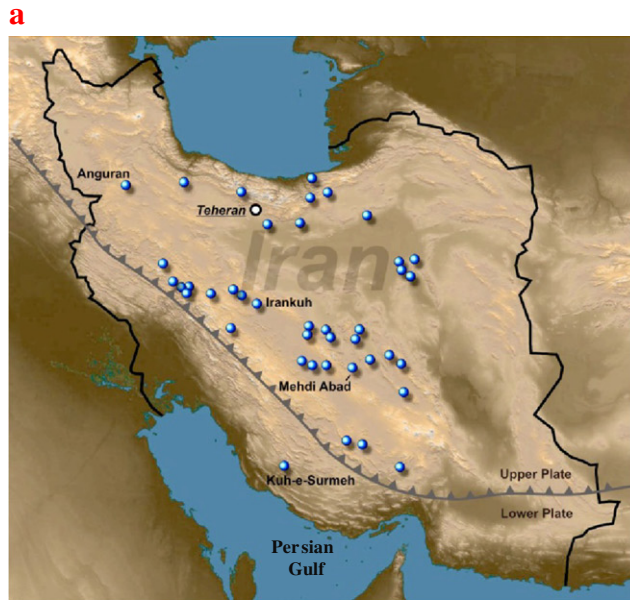


Fig. 1. (a). Location of the Angouran and major nonsulfide zinc ore deposits within the Upper Iranian Plate overriding the Arabian Plate; (b) view looking SE at Angouran pit with Miocene tuffs in the background. The mine office and camp facilities are located on the travertine plateau (background, upper center).

Download English Version:

<https://daneshyari.com/en/article/4697556>

Download Persian Version:

<https://daneshyari.com/article/4697556>

[Daneshyari.com](https://daneshyari.com)