Journal of Economic Geology
Vol. 12, No. 2 (2020)
ISSN 2008-7306

زمین‌شناسی اقتصادی
جلد ۱۲، شماره ۲ (سال ۱۳۹۹)
صفحات ۱۷ و ۱۸

Mineralization, structure, texture and genesis of sediment-hosted Chehrabad Pb–Zn–Cu deposit, NW Zanjan

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Submitted: Aug. 16, 2018
Accepted: Feb. 05, 2019

Keywords: *Sediment-hosted Cu mineralization, Redbed type, Upper Red Formation, Chehrabad, Zanjan*

Introduction

Sediment-hosted stratabound copper (SSC) deposits are bodies of disseminated, cementing, and lesser veinlet hosted copper minerals that are peneconformable with their sedimentary or metasedimentary host rocks (Hayes et al., 2015). These deposits have been termed sediment hosted stratiform Cu, sedimentary rock-hosted stratiform Cu, Cu shale, Cu sandstone, cupriferous sandstones, sandstone Cu, red-bed Cu, Kupferschiefer type Cu, marine paralic type Cu, reduced-facies Cu, or Revett Cu deposits (Cox et al., 2003, 2007; Hitzman et al., 2005; Hayes et al., 2015). SSC deposits occur in three subtypes divided by host lithology and the corresponding type of reductant that precipitated sulfur and Cu from warm, oxidized, metals-transporting, sedimentary brines. These types are as follows: (1) reduced-facies type; (2) sandstone-type (Revett); and (3) red-bed type. These deposits have been formed during the middle-late Paleoproterozoic to Tertiary.

There are several SSC deposits in the Avaj Zanjan Tabriz Khoy area in the northwestern Iran that are hosted by grey sandstone units of the Upper Red Formation (URF). The Tasouj, Tazekand, Nahand Ivand, Ortasou, Chehrabad, Halab, Zagelou and Avaj are the main important deposits in this area. These deposits predominantly consist of bedding-parallel replacement and disseminated Cu–Pb–Zn sulfides, roughly concordant with the stratification. The average Cu, Pb and Zn content of these deposits are ~1.5, 2 and ~1 wt.%, respectively.

Apart from small scale geological maps of the area, i.e., 1:250,000 geological maps of Takab (Alavi and Omidi, 1976), 1:100,000 geological maps of Mahneshan (Lotfi, 2001) and a number of unpublished Pb–Zn–Cu exploration reports, no other work has been reported prior to this research study on Pb–Zn–Cu mineralization at Chehrabad. The present paper provides an overview of the geological framework and the mineralization characteristics of the Chehrabad deposit with an application to ore genesis. Identification of these characteristics can be used as an exploration model for this type of Pb–Zn–Cu mineralization in this area and elsewhere.

Materials and methods

Detailed field work has been carried out at different scales in the Chehrabad area. During the field works, detailed stratigraphic sections were measured, sampled and described. In addition, the color of the sandstone layers and the presence of fossil woods were scanned during the field work. About 23 polished thin and thin sections from host rocks and mineralized layers were studied by conventional petrographic and mineralogic methods at the University of Zanjan in Iran.

Results and Discussion

The Pb–Zn–Cu deposit at Chehrabad, 75 km northwest of Zanjan, is located in the Central Iranian zone. Rock units exposed in this area

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DOI: https://doi.org/10.22067/econg.v12i2.74819

belong to the URF, and consist of alternations of red and green marl intercalated with red to grey, medium- to thick-bedded sandstone. In this area, URF has 980 m thickness and consists of four main parts. These parts, from bottom to top, consist of 1- alternation of gypsiferous green marls along with gypsium and salt layers (235 m), 2- red marls intercalated with grey and red sandstones (445 m), 3- alternation of red and green marls intercalated with sandstones (145 m), and 4- alternation of green marls and green siltstones (155 m). The Pb–Zn and Cu mineralization in the Chehrabad deposit has occurred in grey sandstone units of the second part of the URF. Mineralization has often been formed around and within the fragments of the plant fossils, in the form of disseminated and the solution seems to have been sulfides. Based on field studies, mineralization at the Chehrabad deposit has occurred in two horizons of reduced-grey sandstones, H-A and H-B, with about 4 and 6 m thickness and about 200 and 1000 m length, respectively. These horizons contain red oxidized zone, bleached zone and mineralized reduced zone with the latter being located within the bleached zone.

The red oxidized zone consists of red marl and sandstone layers containing iron oxides which are located adjacent to the reduced horizons. The red color of this zone has been caused by the presence of iron oxides around the grains. The oxidized pyrite crystals are the main important minerals in this zone. The bleached zone is a part of sandstone sequences that have undergone changes in their color due to the alteration processes. Grey and green colors in this zone have occurred due to the presence of organic materials and diagenetic pyrites. Mineralization in the reduced zone has occurred within the organic materials bearing bleached zones. Plant debris, plant fossils, diagenetic pyrites and permeability of host rocks have the most important roles for the Pb-Zn and Cu mineralization at the Chehrabad deposit.

Galena, sphalerite, chalcocite, pyrite and chalcopyrite along with minor Ag-bearing sulfides (mckinstryite, stromeyrite) are the main ore minerals at the Chehrabad deposit. Cerussite, malachite, azurite, covellite, atacamite, vanadinite, and goethite are formed during supergene processes. Disseminated and cemented textures along with lens-shaped, solution seems, replacement, vein-veinlet, and framboidal are the main ore textures at the Chehrabad deposit. Based on the tectonic setting, host rock, geometry, presence of plant fossils, ore structure and texture and mineralogy, it can be concluded that the Chehrabad deposit is a sediment-hosted Redbed type Cu deposit.

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