Journal of Economic Geology
Vol. 7, No. 1 (2015)
ISSN 2008-7306

مجله زمین‌شناسی اقتصادی
جلد 7، شماره 1 (سال 1394)
صفحات 13 و 14

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Investigation on type and origin of iron mineralization at Mesgar occurrence, south of Zanjan, using petrological, mineralogical and geochemical data

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Submitted: Sep. 25, 2013
Accepted: Mar. 18, 2014

Keywords: *Iron mineralization, hydrothermal vein, breccia, alteration, Mesgar, Zanjan.*

Introduction

Mesgar iron occurrence is located in northwestern part of the Central Iran, 115 km south of Zanjan. Although there is a sequence of volcanic-pyroclastic rocks accompanied by iron mineralization, no detailed works had been conducted in the area. The present paper provides an overview of the geological framework, the mineralization characteristics, and the results of geochemical study of the Mesgar iron occurrence with an application to the ore genesis. Identification of these characteristics can be used as a model for exploration of this type of iron mineralization in the Central Iran and elsewhere.

Materials and methods

Detailed field work has been carried out at different scales in the Mesgar area. About 16 polished thin and thin sections from host rocks and mineralized and altered zones were studied by conventional petrographic and mineralogic methods at the Department of Geology, University of Zanjan. In addition, a total of 3 samples from least-altered volcanic host rocks and 2 samples from ore zones from the Mesgar occurrence were analyzed by ICP-MS and ICP-OES for whole-rock major and trace elements and REE compositions at the Zarazma Laboratories, Tehran, Iran.

Results and Discussion

Based on field observation, rock units exposed in the Mesgar area consist of Miocene sedimentary rocks and volcanic-pyroclastic units (Rādfar et al., 2005). The pyroclastic units consist of volcanic breccia and agglomerate. They lie concordantly on the Miocene sedimentary units, and are in turn concordantly overlain by andesitic basalt lavas. The lavas show porphyritic texture consisting of plagioclase (up to 3 mm in size) and pyroxene phenocrysts set in a fine-grained to glassy groundmass. Seriate, cumulophyric, glomeroporphyritic and trachytic textures are also observed.

Iron mineralization occurs as vein and lens-shaped bodies within and along the contacts of pyroclastic (footwall) and andesitic basalt lavas (hanging wall). The veins reach up to 150 m in length and average 1.5 m in width, reaching a maximum of 3 m. Two stages of mineralization identified at Mesgar. Stage-1 mineralization formed before the hydrothermal brecciation events. This stage is characterized by disseminated fine-grained hematite in the andesitic basalt lavas. Clasts of stage-1 mineralization have been recognized in the hydrothermal breccias of stage-2. Stage-2 is represented by quartz, hematite and chlorite veins and breccias cement. This stage contains abundant hematite, together with minor magnetite and chalcopyrite.

The hydrothermal alteration assemblages at Mesgar grade from proximal quartz and chlorite to distal sericite and chlorite-calcite. The quartz and chlorite alteration types are spatially and temporally closely associated with iron mineralization. The sericite and chlorite-calcite alterations mark the outer limit of the hydrothermal system. Supergene alteration (kaolinite) is commonly focused along joints and fractures.

The ore minerals at Mesgar formed as vein and hydrothermal breccia cements, and show vein-veinlet, massive, brecciated, clastic and disseminated textures. Hematite is the main ore which is accompanied by minor magnetite and

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chalcopyrite. Goethite is a supergene mineral. Quartz and chlorite are present in the gangue minerals that represent vein-veinlet, vug infill, colloform, cockade and crustiform textures.

The Mesgar volcanic host rocks are characterized by LILE and LREE enrichment coupled with HFSE depletion. They have positive U, Th and Pb and negative Ba, Nb, P and Ti anomalies. Our geochemical data indicate a calc-alkaline affinity for the volcanic rocks (Kuster and Harms, 1998; Ulmer, 2001), and suggest that they originated from mantle melts contaminated by the crustal materials (Chappell and White, 1974; Miyashiro, 1977; Harris et al., 1986). The ore zones show lower concentrations of REE, except Ce, relative to fresh volcanic host rocks. LREE are more depleted than HREE. These signatures indicate high rock-fluid interaction in Mesgar.

Comparison of the geological, mineralogical, geochemical, textural and structural characteristics of the Mesgar occurrence with different types of iron deposits reveals that iron mineralization at Mesgar is originally formed as volcano-sedimentary, and then reconcentrated as vein mineralization by hydrothermal fluids (Barker, 1995; Marschik and Fontbote, 2001, Shahidi et al., 2012).

Acknowledgements

The authors are grateful to the University of Zanjan Grant Commission for research funding. Journal of Economic Geology reviewers and editor are also thanked for their constructive suggestions on alterations to the manuscript.

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