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

زمین‌شناسی اقتصادی
جلد ۱۲، شماره ۲ (سال ۱۳۹۹)
صفحات ۲۱ و ۲۲

Trace elements geochemistry of galena in fluorite deposits from central Alborz, Mazandaran Province

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Submitted: Dec. 10, 2018
Accepted: May 12, 2019

Keywords: *Trace elements, Galena, Fluorite, Mazandaran*

Introduction

Trace elements including As, Sb, Bi, Ga, Ge, In, Hg, Cd, Tl, Se and REEs have special applications in various industries due to their physical and chemical properties. Ore deposits of these metals have not occurred in the Earth's crust, and these elements are mainly hosted in sulfide minerals of Cu, Pb and Zn (Hall and Heyl, 1968; Song and Tan, 1996; Ye et al., 2011; George et al., 2015). Elika Formation (middle Triassic) in central Alborz is host of several carbonate rock-hosted fluorite deposits such as Kamarposht, Pachi-Miana, Shashroodbar and Era (Alirezaee, 1989; Rastad and Shariatmadar, 2001; Rajabi et al., 2013; Vahabzadeh et al., 2014; Zabihitabar and Shafiei, 2014; Mehraban et al. 2016; Nabiloo et al. 2017). Despite previous valuable studies in these deposits, the value of the presence of trace elements in the galena of these deposits has not yet been documented.

Materials and methods

For the current research study, sampling from 3 flourite mines including Kamarposht, Pachi-Miana and Era was carried out to collect 26 pure galena grains separated from various fluorite ore-types. The samples were analyzed for trace elements at the ICP-MS at Act Labs Ltd., Canada.

Results

The highest concentrations of trace elements in galena samples were obtained for Sb (with mean 692 ppm and maximum concentration of 2531 ppm) and Ag (with a mean of 24.28 ppm and a maximum concentration of 2531 ppm). The lowest values were obtained for Bi (mean 0.04 ppm), Se (average 1.89 ppm) and Ga (mean 0.9 ppm) and Tl (mean 0.3 ppm). Hg (0.06 – 10 ppm), Cd (1.14 – 23 ppm) and As (0.1 – 36 ppm) exhibited a wide range of concentrations.

The comparison of the trace elements concentration in the studied galena samples with those of the MVT, SEDEX, Irish-type deposits shows that the concentrations of Sb, Tl, Hg, Se and Cu in the studied galena are close to the values for MVT deposits, whereas the studied galena samples are much poorer in Ag, Bi, Cd and As than those of the MVT deposits. There is meaningful relationship between concentrations of some trace elements such as Tl –Ag (r=0.82), Tl –Cu (r=0.71), Ag–Sb (r=0.66), Cu –Ag, Ag – As, Cu –As, Sb –Cu, Hg – Zn, As – Sb, Hg – Cd, Zn – Cu ($0.3 < r < 0.6$).

Discussion

Our data revealed that galena samples are relatively rich in Sb (up to 2581 ppm with an average ~ 620 ppm) and Ag (up to 70 ppm with an average ~ 30 ppm), whereas they are poor in other trace elements. Inter-element relationships in galena show strong correlation between Sb – Ag ($r \geq 0.65$) and moderate correlation between Ag – As, Ag –Cu as well as Hg –Zn ($0.4 < r < 0.6$).

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DOI: https://doi.org/10.22067/econg.v12i2.77113

Based on our data, high concentration of Sb and Ag in galena could be related to the presence of special minerals (e.g., tetrahedrite, stephanite, diaphorite, twinnite) as inclusion in the host galena, whereas the occurrence of not very high concentrations of Cd and Hg and meaningful relationship with Zn concentrations in galena could be due to the presence of inclusions of sphalerite (ZnS) and polhemusite (ZnHgS) in the galena. Due to the large presence of galena (several tens of thousands) in the studied fluorite mines, and the relatively high concentration of Sb and Ag in the galena samples of these deposits, an assessment of the economic recovery on a laboratory scale of these elements is suggested.

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