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Mineralization, geochemistry, fluid inclusion and sulfur stable isotope studies in the carbonate hosted Baqoroq Cu-Zn-As deposit (NE Anarak)

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Introduction

The Baqoroq Cu-Zn-As deposit is located northeast of the town ofAnarak in Isfahan province, in theeast central areaof Iran. Copper mineralization occursin upper cretaceous carbonate rocks.Studyof thegeologyof the Nakhlak area, the location ofa carbonate-hosted base metaldeposit, indicatesthe importance of stratigraphic, lithological and structural controls in the placement of this ore deposit. (Jazi et al., 2015).Some of the most world's most important epigenetic, stratabound and discordant copperdeposits are the carbonate hosted Tsumeb and Kipushi type deposits,located in Africa. The Baqoroq deposit is believed to be of this type.

Materials and methods

In the current study, fifty rock samples were collected from old tunnels and surface mineralization. Twenty-two thin sections, ten polished sections and four thin-polished sections were prepared for microscopic study. Ten samples were selected for elemental analysis by ICP-OES (Inductively coupled plasma optical emission spectrometry) by the Zar Azma Company (Tehran) and AAS (Atomic absorption spectrometry) at the Ferdowsi University of Mashhad. Seven doubly polished sections of barite mineralization were prepared for microthermometric analysis. Homogenization and last ice-melting temperatures were measured using a Linkam THMSG 600 combined heating and freezing stage at Ferdowsi University of Mashhad. Sulfur isotopes of five barite samples were determined by the Iso-Analytical Ltd. Company of the UK. The isotopic ratios are presented in per mil (‰)notation relative to the Canyon Diablo Troilite.

Results

The upper Cretaceoushost rocks of the Baqoroq deposit include limestone, sandstone, and conglomerate units. Mineralization is controlled by two main factors: lithostratigraphy and structure. Epigenetic Cu-Zn mineralizationoccurs in ore zones as stratabound barite and barite-calcite veins and minor disseminated mineralization. Open space filling occurred as breccia matrix, crustification banding,andbotryoidaltexture. The host rock has undergone dolomitization alteration

Hypogene minerals include chalcopyrite, pyrite, sphalerite, galena, enargite, barite, and calcite. Supergene minerals include malachite, azurite, covellite, chrysocolla, chalcocite, cerussite, smithsonite, native copper and iron oxide minerals. Sulfantimonides and sulfardenides are abundant in low- and moderate temperature stages of the deposit, while bismuth sulfides generally occur in higher temperature ores, according to Malakhov, 1968.

Analysis of rich ore samples indicates copper is the most abundant heavy metal in the ore (average 20.28 wt%), followed by zinc (average ~ 1 wt%) and arsenic (average ~ 1 wt%), respectively. Thepresence of many trace elements in the ore, such as Sb, Pb, Ag and V, are very important. Element pairs such as Ag-Cu, Zn-Cd, Zn-Sb, Fe-V and Pb-Mo are correlated with each other. The Baqoroq ore minerals are rich in As, Sb and poor in Bi. Highamountsof antimony usually occur in a low temperature stage (Marshall and Joensuu, 1961). Malakhov (1968) suggested thata high Sb/Biratio in the ore indicates a low temperature of formation for the Baqoroq deposit.

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Sulfide mineralization fluids were found to have homogenization temperatures between 259 and 354°C and salinities between 8.37 and 13.18 wt% NaCl eq. Surface water apparently diluted theore-bearing fluids in the final stages and deposited sulfide-freecalcite veins at relatively low temperatures (78 to 112 °C) and low salinities (3.59 to 6.07 wt% NaCl eq.).

The $\boldsymbol{\delta}^{34}$S values of barite of the Baqoroq deposit range from +13.1 to +14.37‰from whichδ34S values of ore fluids were calculated to vary between -8.57‰ and -7.23‰. Sulfur within natural environments is derived ultimately from either igneous or seawater sources (Ohmoto and Rye, 1979). Barite δ^{34}S values of Baqoroq deposit lie within the range of Cretaceous-age oceanic sulfate values. The reduction of sulfate to sulfide couldhave been caused either by bacterial sulfate reduction or by nonbacterial sulfate reduction through a reaction with organic materialin the sedimentary rocks (thermochemical sulfate reduction). However, the narrow range of $\boldsymbol{\delta}^{34}$S and positive values indicates that they were not produced by bacterial sulfate reduction.Partial thermochemical reduction of sulfates has apparently produced light sulfurvalues (~ 21‰ lighter) and it has been effective inthe deposition of ore minerals. Organic matter occurs as graphite in the Baqoroq formation in proximity of Baqoroq deposit (Cherepovsky et al., 1982).

Discussion

Epigenetic, stratabound and discordant Cu-Zn-As mineralization in the Baqoroq deposit occurs as open space filling of upper Cretaceous rocks. Host rock is partially dolomitized by ascending warm, saline fluids. Seawater sulfates were the source of the sulfidesulfur and the sulfate in the barite. The reduced sulfur was generated by partial thermochemical reduction and it was effective inthe deposition ofthe ore minerals. Based onthe evidence of carbonate host rocks, the absence of igneous activity, the open space filling texture, mineralogy, dolomite alteration, ore geochemistry (As and Sb high content and absence of Bi), microthermometric data of ore bearing fluid and sulfur isotope values, the Baqoroq deposit is very similar to the carbonate hosted copper deposits in Africa and in particular the Tsumeb deposit in Namibia. The Baqoroqdepositmay have been produced bymetamorphicfluids during orogenyrelated to theclosureof the Neo-Tethys ocean.

References

Cherepovsky, N., Plyaskin, V., Zhitinev, N., Kokorin, Y., Susov, M., Melnikov, B. and Aistov, L., 1982. Report on detailed geological prospecting in Anarak area (Central Iran) Nakhlak locality. Geological Survey of Iran and Technoexport Company, Tehran. Report 14, 196 pp.

Jazi, M.A., Karimpour, M.H., Malekzadeh, A. and Rahimi, B., 2015. Stratigraphic, lithological and structural controls in placement of Nakhlak deposit (northeast of Esfahan). Advanced Applied Geology, 15(1): 59-75. (in Persian with English abstract)

Malakhov, A.A., 1968. Bismuth and antimony in galena as indicators of some conditions of ore formation. Geochemistry International, 7(11): 1055-1068.

Marshall, R.R. and Joensuu, O., 1961. Crystal habit and trace element content of some galena. Economic Geology, 56(4): 758-771.

Ohmoto, H. and Rye, R.O., 1979. Isotopes of sulphur and carbon. In: H.L. Barnes (Editor), Geochemistry of Hydrothermal Ore Deposits. Wiley-Interscience, New York, pp. 509-567.