American Mineralogist, Volume 109, pages 667–681, 2024

Vapor-phases as Cu transport agents for the shear-zone-hosted mineralization system: A perspective from H-O-S-Cu isotopes

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Abstract

Elucidating metal transport agents is the key to understanding the genesis of deposits and tracking the locations of concealed orebodies. Here, we integrate H-O-S-Cu isotopic data from the shear-zone-hosted Lingyun Cu deposit, China, as a means to fingerprint metal transport agents. Sulfide mineralization can be divided into early and late stages, which consist of chalcopyrite + bornite + quartz veins and chalcopyrite + bornite + ankerite veinlets, respectively. Both $\delta^{18}O_{fluid}$ and δD values of fluid inclusions hosted by quartz ($\delta^{18}O_{fluid}$: 0.5‰ to 9.9‰, δD: –103.9‰ to –60.1‰) and $\delta^{65}Cu$ values of sulfides (–1.85‰ to +0.39‰) from the early stage progressively decrease from the southeastern to northwestern portions of the Lingyun deposit, whereas sulfide $\delta^{34}S$ simultaneously shifts toward heavier values (–14.4‰ to 5.0‰). The $\delta^{34}S$ and $\delta^{65}Cu$ values of sulfides from the late stage have restricted ranges from –11.2‰ to –9.3‰ and –0.30‰ to 0.05‰, respectively. The possibilities of meteoric water addition, water-rock interaction, inter-mineral Cu partitioning, diffusion, and oxidation could be ruled out as reasons for having caused systematic H-O-S-Cu isotope variations. Vapor-liquid separation resulted in preferential incorporation of light Cu, H, and O isotopes into the vapor phase. The decrease in oxygen fugacity in the fluids resulted in a shift toward heavier $\delta^{34}S$ values as fluid flowed outward. Vapor-phases are the dominant transport agents for Cu in the Lingyun deposit, which may be widely applicable to shear-zone-hosted deposits. The direction of progressively increasing $\delta^{65}Cu$, δD, and $\delta^{18}O$ values and decreasing $\delta^{34}S$ values allows identification of potential locations of concealed orebodies.

Keywords: H-O-S-Cu isotopes, Cu transport agent, shear-zone-hosted deposit, Tianshan; Isotopes, Minerals, and Petrology: Honoring John Valley