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Source of ore-forming fluids of the Tianbaoshan Pb-Zn deposit, Southwest China: constrains from C-O, S, and He-Ar isotopes

Jian Wang, Jun Zhang, and Wenbin Zhong
Faculty of Earth Resources, China University of Geosciences, Wuhan, China(cugjwang@163.com)

The Sichuan-Yunnan-Guizhou (SYG) metallogenic province is one of the most important areas for Pb-Zn resources in China. The metallogenic sources of these Pb-Zn deposits have long been debated. In this study, we provide integrated C-O-S-He-Ar isotopic data of the typical Tianbaoshan Pb-Zn deposit, with an aim to constrain the sources of ore-forming fluids.

The Tianbaoshan deposit a large-sized Pb-Zn deposit in SYG metallogenic province, Southwest China. The proven resources include 2.6 Mt metals of Zn+Pb with average grades of 10.09% Zn and 1.50% Pb. The orebodies are hosted within the carbonates of the Ediacaran Dengying Formation. Ore minerals consist mainly of sphalerite, galena, chalcopyrite, and pyrite. Gangue minerals are dominated by calcite and dolomite.

The calcite samples from the Tianbaoshan deposit yield homogeneous $\delta^{13}C_{V-PDB}$values of -1.70‰ to -1.60‰ (average -1.63‰), with $\delta^{18}O_{V-SMOW}$ values ranging from 12.9‰ to 15.2‰ (average 14.4‰). The C-O isotopic data suggest the hydrothermal fluids may be originated from a mixed source involving both mantle and carbonate wall rocks. The $\delta^{34}S$ values of the sphalerite, galena and chalcopyrite samples vary from 3.32‰ to 5.71‰ - 0.36‰ to 1.31‰ and 4.5‰ to 4.7‰ respectively, indicating a magmatic source for sulfur. The $^{3}He/^{4}He$ ratios of chalcopyrite samples range from 0.01 to 0.32 Ra which is slightly higher than the crustal ratios (0.05 Ra), but obviously lower than that of mantle fluids (6 to 9 Ra). The $^{40}Ar/^{36}Ar$ ratios range from 345.0 to 669.1, which are slightly higher than that of air (298.5). The He-Ar isotopic compositions suggest that the ore-forming fluids are dominantly derived from the crust, with litter contamination from mantle-derived fluids.

In combination with the C-O, S, and He-Ar isotopic data, we propose the ore-forming fluids of the Tianbaoshan deposit were derived by mixing of crustal and mantle fluids. And the metallogenic process may be genetically related to the magmatism in this area.