Both thermochemical and bacterial sulfate reduction involved in the formation of MVT Pb-Zn deposits: A case study of the Chipu Pb-Zn deposit, South China

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Revealing the formation mechanisms of reduced sulfur is critical to understanding the genesis of MVT Pb-Zn deposits. A large number of studies have shown that either thermochemical sulfate reduction (TSR) or bacterial sulfate reduction (BSR) play an important role in the formation of MVT Pb-Zn deposits. However, the case of both TSR and BSR involved in the formation of MVT Pb-Zn deposits is rare.

Located in the western Yangtze Block, South China, the Upper Yangtze Pb-Zn metallogenic province covers an area of 170,000 km^2 and contains >400 Neoproterozoic-middle Permian carbonate-hosted epigenetic Pb-Zn deposits totaling >26 Mt of Pb + Zn metal reserves. Among these Pb-Zn deposits, the Chipu Pb-Zn deposit is hosted by dolostone of the late Ediacaran Dengying Formation. In the Chipu deposit, metal minerals are mostly composed of sphalerite, galena and pyrite, and gangue minerals comprise mainly calcite, dolomite and quartz accompanied with large amounts of bitumen.

NanoSIMS in-situ S isotope analysis shows that $\delta^{34}S$ values of sulfides (sphalerite and its symbiotic pyrite) range from -31‰ to +34‰, which are significantly different from the previously reported $\delta^{34}S$ values (+3-+22‰). Furthermore, our sulfur isotope data can be divided into two distinct groups: i) -31‰ to -17‰, and ii) +12‰ to +34‰. The latter group ($\delta^{34}S$=+12-+34‰) is overlap with the previously reported sulfur isotope data ($\delta^{34}S$=+3-+22‰), implying that TSR plays an important role in the formation of reduced sulfur. However, the former group ($\delta^{34}S$ =-31 to -17‰) suggests that in addition to TSR, BSR may also play an important role in the formation of S^{2-}. Further research shows the mixing of two isotopically distinct S^{2-} that was produced by TSR and BSR caused the formation of the Chipu deposit, which means that the local sulfate reduction occurred during the Pb-Zn mineralization. This provides new insights for understanding the origin and ore exploration of MVT Pb-Zn deposits worldwide.

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