

Application of Sb Isotopes in Hydrothermal Sb Ore Formation and Exploration

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In order to investigate and characterize antimony (Sb) isotope fractionation in hydrothermal systems, we present Sb isotope compositions of primary stibnite ores from a giant Sb deposit in south China. A total number of 39 analyses reveals a large $\delta^{123}\text{Sb}$ range of -0.27 to +0.86‰, representing an up to 1.13‰ variation in this hydrothermal system. A gradual increase of Sb isotope ratios from the proximal to the distal parts was observed in stibnite ores. Rayleigh distillation models the systematic variation trend of the Sb isotope values, demonstrating that ore fluids are preferentially enriched in heavier Sb isotopes during the precipitation of isotopically light stibnite. In this way, we consider that separation of stibnite from a Sb-bearing fluid related to reaction kinetics as a cause for Sb isotope fractionation. The modeled data constrain a Sb isotope fractionation factor ($\alpha_{\text{fluid-stibnite}}$) between hydrothermal fluid and stibnite at approximately 0.9994. The model also constrains an initial Sb isotope value of ~0.45‰, which indicates metal sources in the basement rocks of the study area. Given that distal stibnites possess higher Sb isotopic values, Sb isotopes could be well used to fingerprint hydrothermal fluid flow and unravel different processes in natural systems, which will shed new light on Sb ore exploration.