

Sn-isotope fractionation as a record of hydrothermal redox reactions

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ABSTRACT

A redox reaction in which Sn²⁺ oxidizes to Sn⁴⁺ is thought to occur during the precipitation of cassiterite (SnO₂) and stannite (Cu₂FeSnS₄) from high-temperature hydrothermal solutions. In four stanniferous regions with differing mineralization environments (South Dakota, U.S.A.; Cornwall, England; Erzgebirge, Germany/Czech Republic; Andean tin belt, Bolivia), the tin isotope composition in stannite (mean value $\delta^{124}\text{Sn} = -1.47 \pm 0.54\%$, $n = 21$) is consistently more fractionated toward negative values than that of paragenetically earlier cassiterite (mean value $\delta^{124}\text{Sn} = 0.48 \pm 0.62\%$, $n = 50$). Given the oxidation-dependent mechanism for cassiterite precipitation, this isotopic shift is most likely attributable to the oxidation of Sn in solution; precipitation of heavy-Sn-enriched cassiterite results in residual dissolved Sn with lighter isotopic composition, which is expressed in the negative $\delta^{124}\text{Sn}$ values of later-formed stannite. Equally important is that the mean values for the cassiterite from the various deposits are slightly different and may indicate that the initial Sn isotope composition in early-formed cassiterite relates to variations in the source or magmatic processes. Therefore, the Sn isotopes may provide information on both redox reactions and petrologic sources and processes.

Keywords: Tin isotopes, cassiterite, stannite, metal isotope fractionation, redox