The tin isotope fingerprint of tin deposits

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The tin isotopic compositions of cassiterite and stannite from several tin ore provinces were analysed by solution MC-ICP-MS[1]. The samples represent pegmatitic and hydrothermal mineralisation in the Variscan fold belt of Europe (southern England, the Iberian Peninsula, the Ore Mountains in Germany/Czech Republic, Serbia, Slovakia), the Tethyan fold belt in Central Asia (Afghanistan, Tadjikistan) and in the Arabian-Nubian Shield in Egypt. Overall, the isotope composition in cassiterite is highly variable, in terms of $\delta^{124/120}$Sn it ranges from -1.27 to +0.85 ‰, with an average of 0.08 ± 0.53 ‰ (2SD). In each region pegmatitic and hydrothermal mineralisation cannot be discriminated because the range of isotope ratios is similar in both ore types. However, in each region stannite has signifcantly lighter isotope compositions than cassiterite.

The $\delta^{124/120}$Sn values in cassiterite from Variscan mineralisation overlap and vary considerably (-0.33 to +0.85 ‰) but on average the deposits of Great Britain, Germany and from the Balkans have similar isotope ratios (0.11 to 0.16 ‰). Iberian deposits tend to have lighter isotope compositions (0.01 ‰). Similar low average $\delta^{124/120}$Sn ratios are observed in tin deposits from Central Asia (-0.04 ‰).

The central question concerns the cause of fractionation. A significant impact of the tectonic environment, thus a source effect, is not recognised. The similar isotope variation among provinces and among mining areas within a single province, and the large variation within single deposits suggest that the evolution of the fluids in the pegmatitic and hydrothermal systems are essentially controlled by mixing processes, temperature gradients and fractional crystallisation of cassiterite. In pegmatites tin-bearing minerals such as wodginite, and stannite in sulphur-bearing hydrothermal systems, could cause significant mass discrimination as well.

Interdisciplinary mineralogical, geochemical and experimental investigations are needed in order to quantitatively trace the concentration process of economic essential metals such as Sn, W, Nb, und Ta from the source to the granite and to the pegmatitic and hydrothermal ores.

[1] Brügmann et al. (2017) Geostand.Geoanal.Res. doi:10.1111/ggr.12166.