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Tin stable isotope variations for tracing anthropogenic contaminations in sediments of Lake Zurich, Switzerland

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Anthropogenic heavy metal contaminations can be traced using stable isotope systems like Cd or Hg, because isotopic fractionation can occur during contaminant production or transport, leading to different isotopic compositions for natural and anthropogenic sources. Here, we use the unconventional Sn isotope system to trace past Sn contaminations in the sediments of Lake Zurich, Switzerland. We apply a ^{122}Sn-^{117}Sn double-spike method [1, 2] to determine precise Sn concentrations, and isotope compositions expressed as $\delta^{122/118}$Sn relative to the NIST SRM 3161a Sn standard. We analysed samples from the south and north part of the lake (cores ZH09-02 and ZH09-05, respectively). Our results show that samples older than the 1880s possess very low Sn concentrations below 8 ppm, and low $\delta^{122/118}$Sn values similar to that of andesitic and granodioritic samples [1], likely reflecting the natural Sn isotopic composition in the catchment of Lake Zurich (Fig. 1). Samples between 1880 and 1950 fall on a mixing line between the natural background and the most contaminated samples from the 1900s, which display high $\delta^{122/118}$Sn values. These are attributed to a silk dyeing industry in Thalwil in the north-west of the lake, where the Sn concentration can reach up to 10 dry wt%. However, one sample from 1904 in the south part of the lake has a higher $\delta^{122/118}$Sn than the most contaminated samples. This potentially indicates the contribution of another synchronous pollution source characterised by very high $\delta^{122/118}$Sn, possibly near other known contamination sites in Richterswil or Stäfa. In the 1960s, we observe a second concentration increase, with lower amplitude, but widespread over the lake, characterized by a with slightly lower $\delta^{122/118}$Sn than natural levels. This points towards a younger contamination source. Recent Sn levels are slightly higher than the natural background in terms of concentrations and isotopic composition. In summary, the Sn isotope system allows us to distinguish various pollution sources using their isotopic variations in combination with Sn concentrations, despite the limited isotopic variations close to the resolution limit.

[1] Friebel (2018), PhD thesis, ETH Zurich.

[2] Friebel, Toth, Fehr & Schönbächler (2020), *JAAS*, *35*(2), 273–292.

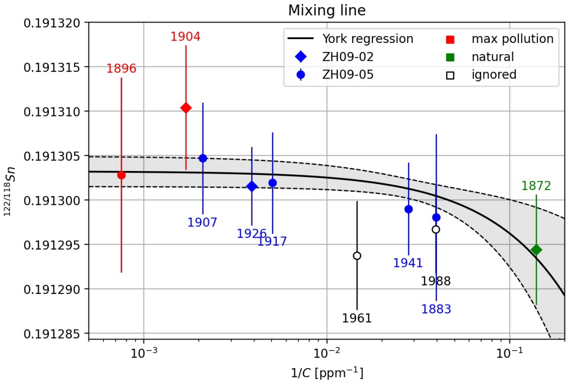

Fig. 1: Preliminary results for the Sn isotopic ratios as a function of the inverse of the Sn concentration $1/C$ for ZH09-02 (diamonds) and ZH09-05 (dots). Isotopic mixing line (black line) for blue samples between the natural (green) and polluted (red) end-members. The white ratios are not considered for the mixing line.