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Antimony Isotope Fractionation in Natural Tropical River Water Systems

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Antimony (Sb) is a highly mobile toxic element ubiquitous in the environment due to natural processes and human activities. Recent analytical developments have demonstrated that Sb isotopes can be useful geochemical proxies for tracing sources and processes of pollution in mine-affected regions [1]. However, the Sb cycle in low-temperature systems and the geochemical controls in uncontaminated natural waters remain poorly understood.

To address this issue and better understand Sb isotope behaviour in natural systems, we investigated the Sb isotopes in three rivers (Wanquan, Shilu, and Changhua) on the tropical island of Hainan (South China), which lacks significant Sb deposits. Water samples were collected from the source to the estuary and filtered through a pore size of 0.2 µm, representing the dissolved load. The Sb and Fe concentrations and Sb isotope compositions ($-0.35 \leq \delta^{123}Sb \leq +0.58$ ‰) were obtained on the dissolved load with variable pH (~7.1 to 8.4), conductivity (67.4 to 263 µS), and DO (27 to 74 %).

The Wanquan River exhibits a narrow isotopic range (–0.31±0.08 ‰ (2SD)) at constant Sb, Fe concentrations (2.4±0.4 (Sb), and 55.7±11.1 (Fe) µg/L). In contrast, the Shilu River is impacted by mine drainage from the Shilu iron oxide-copper-gold deposit and shows a progressive increase towards significantly heavier isotopic compositions (+0.34 to +0.58 ‰). Headwaters of the Changhua River are isotopically similar to those of the Wanquan River, but evolve towards heavier isotopic compositions at the confluence with the Shilu River.

The Sb isotope composition of the Wanquan River, which is significantly lighter than the bulk silicate Earth with 0 ‰ [2], appears to be dominated by the release of ^{121}Sb from the dissolution of Fe oxides during rain events. While the observed evolution of Sb isotopes towards heavier compositions in the Shilu River is most likely related to adsorption processes, such as to particulate-sized Fe oxides that exceed the filter size, resulting in a depletion of ^{121}Sb in the dissolved load. This further supports the notion that Sb scavenging is primarily driven by Fe oxides.

[1] Wen et al. 2023 *J. Hazard Mater*. 446, 130622.
[2] Kaufmann et al. 2024 EGU24-10027