Development of Sb isotopes as tracers of Sb mobility in the environment

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Antimony (Sb) is an emerging contaminant that may occur in high concentrations associated with mining, fire retardents, munitions, and in commonplace consumer products. The bioaccessibility and mobility of Sb are often governed by biological transformations, where Sb, once reduced to Sb(III), may precipitate as an insoluble mineral phase (e.g. stibnite). The stable isotopic ratio of Sb, $^{123}Sb/^{121}Sb$, has been shown to fractionate in two studies of abiotic reduction and several studies have measured ca. 1.5‰ isotopic variation in natural systems [1, 2]. However, in order to assess the practicality of the isotope ratio as a tracer of Sb mobility, the Sb isotope systematics during biological and naturally relevant abiotic redox reactions must be characterized.

In this study, we present the first determinations of fractionation factors associated with naturally attenuating pathways such as adsorption, biological reduction, and abiotic reduction. Using MC-ICP-MS, we are able to attain precise isotope ratio measurements (±0.06‰ 2σ) using standard-sample bracketing to correct for instrumental mass bias. Importantly, a hydride generation sample introduction system [1] allows for high sensitivity (~7 ng Sb per measurment). Preliminary batch incubations of two anaerobic bacterial isolates, Strain BD-1 and Strain WVSBR-1, amended with lactate and tryptone, respectively, produced a fractionation of -0.50 to -0.64 ±0.1‰ during reduction of Sb(V) to Sb(III). For the latter incubation, an additional isotopic fractionation (~-0.2‰) occurred between the dissolved Sb(III) and stibnite. In addition, Sb(V) and Sb(III) adsorption to goethite at circumneutral pH revealed 0.6 ‰ and 0.4‰ fractionation, respectively (adsorbed Sb is lighter). These results may complicate our interpretation of the isotopes as Sb reduction indicators, and highlight the need for greater characterization of these fractionating pathways to fully assess the potential of Sb isotopes as a tracer of Sb immobilization.

[1] Rouxel et al. (2003) *Chemical Geology* **200** 25–40
[2] Wen et al. (2017) *International Biodet. and Biodeg*. **128** 109-116