Insights to Hydrothermal Processes using Mercury Isotope Ratios

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Mercury isotopes in environmental applications have been used to trace sources and pathways of Hg using mass-dependent fractionation (MDF; δ^{202}Hg), and to interpret kinetic processes (e.g., photooxidation) using mass-independent fractionation (MIF; Δ^{201}Hg) of odd-numbered isotopes [1, 2].

In this study, we evaluate how different physicochemical processes, including mixing between meteoric and hydrothermal waters, boiling, and sorption, affect Hg isotope composition in YNP thermal waters. Samples for mercury were collected from filtered (0.45µm; fTHg) and unfiltered (uTHg) water from 14 thermal features with a broad range of geochemical compositions (2.1-9.2 pH; 20-73 ng/L fTHg; 48-28,500 ng/L uTHg). The isotopic composition for Beryl Spring (pH 6.6, 21 ng/L fTHg), a deep hydrothermal fluid end-member, was 0.15±0.03‰ δ^{202}Hg, and 0.27±0.04‰ Δ^{201}Hg in the filtered water. The δ^{202}Hg for Upper, Midway, and Norris Geyser Basin filtered waters reflects MDF through the mixing of this hydrothermal end-member with meteoric-derived waters. Anomalous MIF was found for Turbulent Pool (pH 2; 39 ng/L fTHg; -0.67±0.04‰ Δ^{201}Hg) an end-member fluid with a dominantly meteoric source with subsurface hot gas discharge, and in Mustard Spring (pH 8.1; 42 ng/L fTHg; 0.51±0.04‰ Δ^{201}Hg), a geyser with surface boiling. Paired filtered and unfiltered samples were examined for potential sorption-related fractionation. There was a strong, positive shift for δ^{202}Hg from unfiltered to filtered water in pH<6 springs. This is reversed for two springs with pH>8, where δ^{202}Hg increases from the filtered to unfiltered water samples. While there are some general trends in isotopic composition related to pH and T, the systematic Hg isotopic composition of individual features reflects multiple geothermal processes that affect their chemical composition.

[1] Ghosh *et al.* (2008) *Geochem, Geophys, Geosyst.* **9** Q03004. [2] Bergquist & Blum (2009) *Elements* **5**, 353-357.