

Tracing local industrial pollution sources with mercury isotopes

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Stable mercury (Hg) isotope analysis offers a promising tool for tracing sources of anthropogenic Hg pollution in the environment. Mass-dependent (MDF) and mass-independent fractionation (MIF) of Hg isotopes results in two-dimensional isotope signatures of different Hg sources and can help understand transformation processes at contaminated sites.

Here, we present Hg isotope data for sediments collected in the vicinity of different industrial pollution sources in Sweden. The sampling sites covered a range of environmental conditions (salinity, organic matter, temperature) and were contaminated with either elemental Hg from the chlor-alkali industry or with phenyl-Hg used as preservative for pulp fibers in the paper industry. In addition to analyzing total sediment digests, a sequential extraction method designed to separate sulfide- and non-sulfide-bound Hg was performed on selected samples. Stable Hg isotope ratios were measured by CV-MC-ICPMS using standard-bracketing (NIST-3133) and Tl addition for mass bias correction.

The sediments exhibited a wide range of total Hg concentrations from 0.8 to 229 $\mu\text{g g}^{-1}$, consisting dominantly of organically-bound Hg(II) and a smaller pool of sulfide-bound Hg. The Hg isotope ratios of the three phenyl-Hg sites displayed nearly identical signatures (MDF $\delta^{202}\text{Hg}$: -0.2 to -0.5‰, MIF $\Delta^{199}\text{Hg}$: -0.05 to -0.10‰). In contrast, the four sites which had been contaminated with elemental Hg showed much greater variations ($\delta^{202}\text{Hg}$: -2.1 to 0.6‰, $\Delta^{199}\text{Hg}$: -0.19 to 0.03‰), but with distinct ranges for the different sites.

The sequential extraction data revealed that the smaller sulfide-bound Hg pool was in some samples up to 1‰ heavier in $\delta^{202}\text{Hg}$ than the dominant organically-bound Hg pool. The selectivity of the sequential extraction procedure was assessed using standard materials prepared with enriched stable Hg isotope tracers, which also allowed to gain insight into the exchange of Hg isotopes between different Hg pools.

Our results suggest that different industrial pollution sources can be distinguished based on their Hg isotope signatures, which can additionally record fractionation processes between different Hg pools in the sediments.

Geochemical and isotopic investigation of fluids from Lahendong geothermal field

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Lahendong geothermal field is a high-temperature liquid-dominated system located in North Sulawesi (Indonesia) with a current power production capacity of 80 MW (Operator: Pertamina Geothermal Energy). The geology of the area comprises Late Pliocene to Mid-Pleistocene volcanic rocks of Mount Tondano and younger eruptions, including basaltic and andesitic lavas and pyroclastics [1,2]. Deep reservoir fluids are dominated by Cl-SO₄-HCO₃ and Cl type, while HCO₃-rich and SO₄-HCO₃ type fluids discharge at the surface [2].

We investigated trace elements and naturally occurring isotope systems (D-O, Sr, Ca) in fluids from hot springs, shallow groundwater wells, geothermal production wells, and surface waters from the Lahendong area to elucidate solute sources and geochemical processes in the aquifer. δD and $\delta^{18}\text{O}$ values of the fluid samples suggest a meteoric origin of geothermal groundwaters. Variable trace element concentrations are subject to differences in weathering regime and geochemical equilibrium conditions in the aquifer. Deep fluids are usually characterized by high As (≤ 4 mg/L), Cs (≤ 1.4 mg/L), and Li (≤ 2.3 mg/L) and low Ca and Mg concentrations (≤ 6 mg/L). In turn, surface waters and hot springs have higher Ca and Mg concentrations but are low in As, Cs, and Li content (<0.5 mg/L). $^{87}\text{Sr}/^{86}\text{Sr}$ ratios are lower in surface waters and hot springs (0.7039 – 0.7043), while fluids of the deeper reservoir have higher $^{87}\text{Sr}/^{86}\text{Sr}$ ratios (0.7050 – 0.7057), which suggests differences in the Sr isotope composition of andesitic and basaltic rocks in the reservoir and at the surface. $\delta^{44/40}\text{Ca}$ values vary between -1.50 and 0.09 ‰ and may be employed as an indicator for processes involving dissolved Ca²⁺. These processes include dissolution of minerals, cation exchange, and precipitation of secondary Ca-bearing phases.

[1] Koestono *et al.* (2010) Proceedings World Geothermal Congress 2010; Bali, Indonesia. [2] Utami *et al.* (2007) Proceedings 29th NZ Geothermal Workshop 2007.