# Mercury isotope fractionation in layered roasted ore waste

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High concentrations of mercury (Hg) can often be found in the environment around inactive Hg mines. During mine operation, rock containing the primary ore mineral HgS was crushed and heated in furnaces to temperatures of ~ 700 °C (calcination). Most of the resulting elemental Hg vapor was condensed and collected and the remaining mine tailings (calcines) were piled on site. This removal process was not complete and significant amounts of Hg remained in the calcines. Large pieces of calcine often exhibit a characteristic internal layering, with dark-grey cores, light-grey outer rims, and red outer surface layers. The speciation of the Hg-bearing compounds in these wastes determines the solubility, volatility, and thus mobility of the remaining Hg [1, 2].

Various environmental processes fractionate the stable Hg isotopes via mass-dependent (MDF) and/or mass-independent fractionation (MIF); however, the controlling mechanisms are not fully understood. These isotopic signatures provide a promising new tool for further understanding Hg transformations and emissions from highly contaminated mining sites. Here we report stable Hg isotope results for different layers in calcine cobbles collected at the inoperative New Idria Hg mine, San Benito County, CA, USA.

Differently colored layers in the calcines were carefully separated, powdered, and digested following either total or sequential procedures [3]. Isotopic analyses were performed on a Nu Plasma MC-ICP-MS with cold vapor introduction.

Our analyses revealed significant concentration gradients across the different layers, with higher Hg concentrations in outer rims and lower concentrations in inner regions. In all sequential extractions, the 12M $HNO_3$ soluble fraction displayed the highest Hg concentration. In general, bulk calcine samples were isotopically heavier than ore and unroasted ore wastes, and significant MDF $\delta^{202}$Hg gradients existed from isotopically heavy centers to lighter rims. These findings suggest that incomplete roasting of ore rocks led to pronounced Hg isotope gradients which were presumably caused by kinetic effects during diffusive processes.

[1] Kim *et al*. (2003) *ES&T* **37**, 5102–5108. [2] Jew *et al*. (2011) *ES&T* **45**, 412–417. [3] Bloom *et al*. (2003) *Anal. Chim. Acta* **479**, 233–248.

# Toward establishing precise chronologies for the integration of Late Pleistocene palaeoclimate archives: An example from Suigetsu SG06, Japan

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To further understand abrupt climate changes, and any geographical leads and lags, it is important to precisely correlate high-resolution terrestrial, marine and ice core archives from around the globe. This requires improved dating techniques and methods for correlating these sedimentary archives. Volcanic ash (tephra) layers provide ideal markers to synchronise records over regional areas, and $^{40}Ar/^{39}Ar$ eruption ages can provide direct temporal constraints. Here we discuss the methodology used to obtain high-precision $^{40}Ar/^{39}Ar$ age of a tephra within the SG06 Suigetsu archive.

The 73 m-long SG06 core from Lake Suigetsu, Japan provides continuous record of sedimentation spanning the last ~150 kyrs [1] and represents one of the most important Late Pleistocene palaeoclimatic records. SG06 is annually layered (varved) down to ~65 kyrs and contains numerous terrestrial plant macrofossils, from which a varve chronology and radiocarbon analyses are currently being paired to generate a wholly terrestrial radiocarbon calibration dataset that extends to the older limit of the radiocarbon analytical method (see [1]). We present our $^{40}Ar/^{39}Ar$ ages along with the varve and $^{14}C$ chronology to show that it is possible to get accurate and precise ages of eruption units that are near the young limit of the $^{40}Ar/^{39}Ar$ method.

[1] Nakagawa *et al*. (2011) *Quaternary Science Reviews*, in press.