

Highlights of Analytical Sciences in Switzerland

Division of Analytical Sciences

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Reactivity of Soil Mercury by Stable Isotope Dilution

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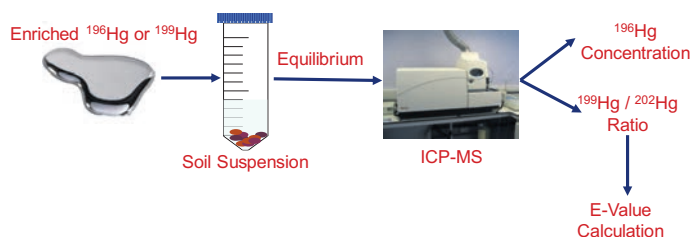
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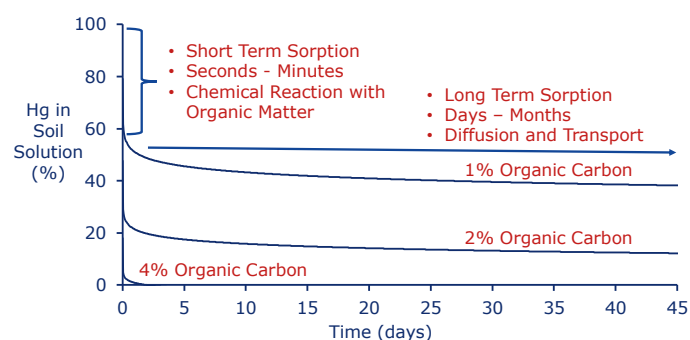
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Recognition of global mercury (Hg) pollution has prompted research and policy development that led to the 2013 UN's Minamata Convention aiming to reduce human exposure to this neurotoxin.

Soil plays a key role in the global cycle of Hg. The bioavailability of soil Hg, and consequently its potential health risks, are a function of its reactivity. Traditionally, the reactive fraction of soil Hg has been determined by chemical extraction; however, extraction methods are prone to many inaccuracies resulting from the enforced release of solid-phase Hg to the extraction solution.



Isotopic dilution procedure.



Temporal reduction in the solution phase concentration of Hg added to soil microcosms. The sorption kinetics of Hg were modelled using a parameterized Elovich expression fitted to the experimental data of $^{196}\text{Hg}^{+2}$ sorption in soils with different properties. Modelled lines are displayed for a range of soil organic carbon values at a fixed pH of 4.4.

Stable isotope dilution (SID) has recently become the most promising approach to estimate the reactivity of soil metals due to the greater availability and abilities of Inductively Coupled Plasma Mass Spectrometry (ICP-MS). However, the logistical and analytical complexities resulting from the multiple stable isotopes and chemical forms of Hg has made it very challenging to apply SID on Hg.

We have developed, for the first time, a SID protocol to quantify Hg lability (Hg-E) in soils using enriched ^{199}Hg (spike isotope) and ^{202}Hg (reference isotope). Application of the developed protocol on soil samples collected from Visp, Switzerland, delivered novel knowledge in comparison to the conventional extraction methods. The reactive Hg pools estimated by $\text{CH}_3\text{COONH}_4$ and MgCl_2 extractions were considerably lower than the Hg-E values. However, the limited range of Hg-E (12–25% of total Hg), as opposed to the wide range of total Hg concentrations (0.37–310 mg kg^{-1}), demonstrated the capability of soils to stabilise large amounts of Hg, and therefore diminishing the risks of Hg transfer to humans and animals.

The temporal change in the solubility of newly added Hg to soils was also followed and modelled using trace levels of $^{196}\text{Hg}^{+2}$ spikes. The very low natural abundance of ^{196}Hg (0.15%) rendered it a perfect candidate to study the reactivity of Hg in soil under almost natural conditions. Kinetic simulations of the obtained results predicted that in organic-rich soils Hg is immobilised within minutes of contact, whereas in alkaline arid soils Hg may remain reactive for many years.

Our investigations demonstrated the viability and versatility of stable isotope dilution methods to study and predict the fate of Hg in soil and to assess its potential risks with high precision and with minimum disturbance to the natural soil equilibrium.

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References

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