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Comparison of arsenic and mercury release linked to iron and sulfur biogeochemical processes

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Understanding and predicting the mobility of redox-sensitive metals, such as arsenic (As) and mercury (Hg), in aquifers is important to reduce their adverse effects. Both these metals have a strong affinity for iron (hydr)oxides that control their sequestration and their bioavailability in soils and aquifers, in strong relation to microbial activity and physico-chemical conditions.

The aim of this work was to study the mineralogical transformations, induced by bacterial consortia collected in polluted environments, leading to arsenic or mercury release and speciation in controlled column systems under anoxic conditions.

The experimental setup consists of columns filled in the lower half with sand and in the upper half with a mixture of sand and iron oxides, initially doped with either arsenite As(III) or mercury Hg(II). The system is inoculated with the bacterial consortia of polluted aquifers and a nutritive medium is then circulated through the system in which biological and physico-chemical parameters were followed.

The effect of the activity of sulfate-reducing bacteria on arsenic mobilization was demonstrated at the interface between the Fe-rich zone and the zone without Fe: the biotic reduction of solid Fe(III) or the abiotic reduction by HS⁻ are both possible. The increase of the energy gain for both reducers (iron and sulfate reducers) is also suggested and this phenomenon could explain the elevated As concentrations seen in certain aquifers (e.g. Bengal delta aquifers).

Other column experiments are presently being carried out to elucidate mercury redox transformations in similar conditions: the reduction of Hg(II) to volatile Hg⁰ and methylation to HgCH₃⁻ are both likely to take place in such anoxic conditions and could increase the mobility of mercury.