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Antimony cycle in wetland under climatic events: role of Fe oxyhydroxides and organic matter

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Antimony (Sb) is a strategic element for industry and necessary for emerging new technologies. However, Sb is a toxic and potentially carcinogenic metalloid whose release (e.g., mining, metal-ores processing activities) into the environment threatens soil, water quality and human health.[1] Climatic models predict that the frequency and intensity of rainfalls will increase as the climate changes. Therefore, the question of the mobility of metal(loid)s in the environment in response to extreme hydrological events is of primary interest, especially in wetlands, which are highly sensitive to chemical changes because of their high reactivity of iron (Fe) oxyhydroxides and organic matter (OM). Wetlands play a buffer role as they receive, transform, store, and/or release metalloids from natural and anthropogenic sources. The behavior of Sb is controlled by the variability of the physicochemical conditions, the properties of their bearing phases (Fe-Mn oxyhydroxides, clays, OM), and microbial activities that contribute to Sb(III) oxidation or Sb(V) reduction. The mobility and bioavailability of Sb are strongly dependent on Fe speciation[2], which is related to the physicochemical conditions leading to different degrees of crystallization, morphologies, surface areas, and sizes of Fe oxyhydroxides. Therefore, the simultaneous study of Fe and Sb speciation changes in interaction with OM is required to identify the Sb remobilization in contaminated wetlands stressed by significant redox modifications because of extreme flooding.

A series of batch experiments was performed using lepidocrocite, a common Fe oxide in wetlands, a precursor of more crystalline Fe oxides, and very sensitive to redox and host for Fe-reducing bacteria. An Sb(III) solution was added to the incubated slurries prepared with or without humic acid and Fe-reducing bacterial cell suspension. Three redox cycles were imposed by changing the gas phase composition. In all batches, an Sb(III) oxidation to Sb(V) in solution, and a release of soluble Fe, progressively occurred with the repetition of the redox cycles. The Sb remobilization and speciation in wetlands seems being controlled by the Fe reduction catalyzed by Fe-reducing bacteria.

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[2] Burton, Hockmann & Karimian (2020) *ACS Earth and*