Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.14373

Immobilisation of antimony by hydrogel-nanomagnetite aggregates in flow-through microfluidic systems

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Antimony (Sb) is a redox sensitive, toxic metalloid, ubiquitously present in the environment, included in the priority pollutants list of US-EPA and EU-EEA **[1]**. Excess intake by humans may cause toxicity-related, health problems **[2]**, leading to a worldwide attention for Sb water decontamination. Magnetite has a great adsorption capacity among solid phases **[3]**, and its ability to retain metal(loid)s on its surface is an important factor of the immobilisation of antimony compounds **[4]**. Antimony speciation in such process is of primary significance, with Sb^{+3} being more toxic and less soluble than Sb^{+5}. Studies on time and pH dependence of Sb reduction by nanomagnetite demonstrated the reduction of Sb^{+5} and adsorption of Sb^{+3} as tridentate surface complex on the (111) face of magnetite/maghemite **[5]**. Polymer coatings can also stabilize such iron (oxyhydr)oxides with respect to aggregation, maximizing their adsorption capacity **[6]**. Bionanocomposite aggregates may then be used to immobilize antimony in water treatment plants, and here we mimic those systems in a microfluidics setup, ideal to study time-dependent Sb reduction reactions.

With the aim to visualize the diffusion of Sb within those aggregates, and its speciation alternation throughout the hydrogel matrix, we performed flow-through microfluidic experiments, using PEGDA/Chitosan-nanomagnetite aggregates, reacted with antimony solutions at various concentrations. Our results on L-edge Sb XANES measurements showed Sb^{+5} reduction to Sb^{+3} to be favoured at relatively low Sb input concentrations, i.e., at less than 200% coverage of nanomagnetite reactive sites. Our study allowed us to investigate the temporal/spatial distribution and oxidation state of Sb species (and thus the reduction by nanomagnetite), and to study Sb retention time. This work provides insights into the role of nanomagnetite aggregates into the immobilization of Sb, as a novel remediation strategy for drinking and waste water treatment plants.

[1] Filella et al., 2002, *Earth Sci Rev*, *57*(1-2), 125-176. **[2]** Wilson et al., 2010, *Environ pollut*, *158*(5), 1169-1181. **[3]** Missana et al., 2009, *Geochim Cosmochim Acta*, 73, 6205-6217. **[4]** Verbinnen et al., 2013, *Waste Biomass Valorization*, *4*(3), 635-645. **[5]** Kirsch et al., 2008, *Mineral Mag*, 72, 185-189. **[6]** Wu et al., 2008, *Nanoscale Res Lett*, 3 (11), 397e415.