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Coupling of trace metals and metalloids to microbial Fe(III) reduction; impacts on Ce and Sb mobility and the production of novel nanomaterials

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The influence of biogeochemical processes on the fate of metals has received a lot of attention in the literature, as microbial activities can control the mobility of toxic metals, and can also be harnessed for the biotechnological production of high value metallic nanoparticles. In the present studies, the fate of Ce and Sb was studied during the bioreduction of Fe(III) oxyhydroxides mediated via the dissimilatory metal-reducing bacterium *Geobacter sulfurreducens*. Cerium is one of the most abundant rare earth elements (REE) in the environment and is used widely in industrial applications[1]. In contrast, Sb is an emerging contaminant that is potentially toxic in aquifers[2].

Ce-bearing ferrihydrite was prepared by the co-precipitation of ferric chloride ($FeCl_3$) and cerium chloride ($CeCl_3$). Sb(V) was adsorbed to pre-made ferrihydrite before bioreduction. Increased loadings of Ce and Sb impacted on the rate and extent of Fe(III) reduction, but did not result in Sb(V) or Ce mobilisation, suggesting a strong affinity between the Fe(III) mineral and Ce/Sb. After bioreduction, magnetite was the dominant Fe(II)-bearing phase detected by XRD in the low Sb(V) or Ce-bearing samples (0.5% and 1%) and was accompanied by a small amount of goethite. For samples containing higher Sb or Ce, bioreduction of Fe(III) was inhibited, and goethite was the dominant end-point detected. In both examples, Sb and Ce were retained within the iron mineral assemblage, suggesting that tight coupling to the iron redox cycle will not result in groundwater contamination, but could instead be used to control pollution in the environment. In addition, reductive bioprocessing of Fe(III) minerals with trace contaminants can lead to the production of useful nanomaterials. Here the biomagnetite prepared with 0.5% Ce was tested as an addititive to Pt/C fuel cell electrodes, and improved their performance at lower loadings of Pt, suggesting that microbially produced Ce-magnetite (potentially from wastes) can provide a sustainable way to improve the performance of fuel cell catalysts[3].

Reference

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2. Li,J.et al. (2016) Applied and environmental microbiology 82 (18): 5482-5495.
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