Comparative im/mobilization of As, Cr, Sb in argillaceous and soil suspensions

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Oxyanion behavior in subsurface environments strongly depends on redox conditions and on the presence or absence of other redox active components[1]. Here, we contrast contaminant im/mobilization in a natural soil to argillaceous clay-rich suspensions. We focus on the oxidation state, sorption affinity and mobility of arsenic (As), chromium (Cr) and antimony (Sb) under various redox conditions. We performed experiments using bio-reactors to impose temporal oscillations between anoxic and oxic conditions. This resulted in substantial redox potential (E_H) fluctuation in soil suspensions (-320 to +450 mV, pH ~7), but only small changes in clay-rich suspensions (+250 to +340 mV, pH ~7).

Cr(6) was removed from the aqueous phase during the first 7 days for both substrates and was not subsequently remobilised. This suggests irreversible reduction of soluble Cr(6) to insoluble Cr(3). Total aqueous As and Sb concentrations oscillated along with oxic/anoxic transitions in the soil suspension, but decreased steadily in the clay suspension. Speciation analyses indicate reduction coupled to ethanol oxidation in both soil and clay systems. Comparisons between biotic experiments and sterilised controls suggest that reduction is microbially induced. Based on thermodynamic predictions end-products of As and Sb reduction are likely Sb_2O_3 or $HSbO_2$ and $CaHAsO_3(s)$.

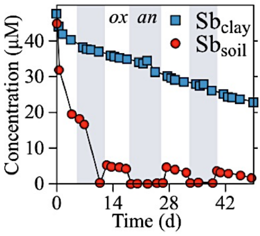

Fig. 1: Antimony (Sb) removal by soil (circle) and clay (square) in bioreactors.

Overall we observed a contrast in contaminant behavior between soil and argillaceous clay-rich substrate (Fig. 1). We ascribe this to the presence of Fe and Mn oxides in the soil, which can act both as sorbents and as catalysts for oxidation.

[1] Couture, R.-M *et al*. (2015) *ES&T* **49**, 3015–3023.