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Fate of hexavalent chromium in a multicomponent system

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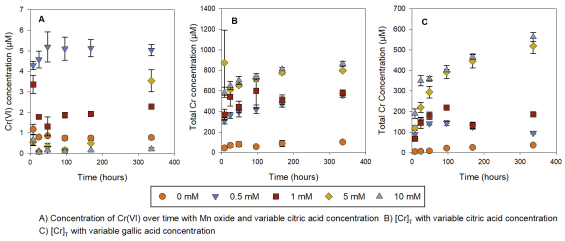

A) Concentration of Cr(VI) over time with Mn oxide and variable citric acid concentration B) $[Cr]_T$ with variable citric acid concentration C) $[Cr]_T$ with variable gallic acid concentration

Toxic chromium (Cr) contamination of soils and water from anthropogenic and geogenic sources is a pervasive environmental and health issue. The toxicity of Cr is highly dependent on its interactions in the environment. Manganese (Mn) oxides are very ubiquitous, and prolific in facilitating Cr(III) oxidation [1]. Also, in environmental systems, Cr availability and reactivity is dependent on the suite of structurally diverse natural dissolved organic carbon (DOC). These confounding factors make it difficult to assess the specific risks of Cr contamination in natural systems.

The objective of this study is to evaluate the mechanisms of Cr redox dynamics as function of Mn-induced oxidation, DOC concentration and DOC functional group composition. To address these objectives, mixed batch experiments using synthesized Cr hydroxide, manganese oxide (50 nm), citric and gallic acid as DOC source was conducted for a period of 2 weeks. Dissolved Cr(VI), total Cr $[Cr]_T$ and Mn $[Mn]_T$ has been be quantified in order to elucidate mechanisms of Cr(VI) production across DOC gradients of 0.5 – 10 mM.

Preliminary results at pH 5 show that Cr(VI) production is a function of citric acid concentration. At a starting of concentrations 0.5 mM, citric acid caused rapid Cr(VI) production which peaked at 5.2 µm within 48 hours. However, within the same period, 10 mM citric acid produced 7.5 times less Cr(VI) (Fig A). This is lesser than the 1.92 µm threshold for total Cr set by the USEPA for drinking water [2]. Conversely, increasing concentration of citric and gallic acid increased $[Cr]_T$ concentration (Fig B and C).

Ongoing work seeks to quantify Cr(VI) concentration with gallic acid as DOC and measure changes in gallic acid and citrate concentrations in concert with Cr redox processes. X-ray absorption spectroscopy data are being analyzed to determine solid phase speciation of Cr and Mn. These results will show the efficacy of DOC in limiting Cr oxidation and help better understand fate of Cr in multi-component systems.

References

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