

Arsenic mobilization in the critical zone: Oxidation by hydrous manganese oxide

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Manganese(IV) oxides represent one of the main redox catalysts in the subsurface environment, while also extensively sorbing a number of anions and cations. Their wide-spread distribution in soil, combined with their highly reactive surfaces, allow manganese (Mn) oxides, even in low concentrations, to oxidize trace metals such as arsenic from arsenite [As(III)], which is fairly toxic and mobile, to arsenate [As(V)], a much less reactive and mobile species. However several variables can influence the oxidation reaction including particle size. Also, as manganese oxide minerals age under natural conditions they can go through an Ostwald ripening process, where the numerous small crystalline particles formed at first begin to precipitate into a larger, more crystalline structure, having the potential to significantly reduce surface area and thus overall reactivity. Hydrous manganese oxide (HMO), a poorly crystalline Mn oxide, was synthesized with an initial particle size of 700 nm. Upon exposure to HMO As(III) rapidly converted to As(V). However, a decrease in reactivity and increase in particle size was observed during the next four weeks. In addition, several other techniques were employed to vary HMO particle size. Heating, chilling or adding sulfuric acid in addition to the standard procedure appeared to increase particle size up to several microns, while sonicating or reducing the formation time decreased particle size to as small as 175 nm. Scanning Electron Microscopy was used to characterize the various manganese oxides.

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