

MOBILIZATION OF OXIDE-BOUND TOXIC METALS BY ORGANIC REDUCING AGENTS AND COMPLEXING AGENTS

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Within oxid soils and aquifer sediments, manganese(III,IV) oxides and iron(III) oxides are important sorptive phases of toxic metals such as Co(II,III), Ni(II), Cu(II), and Pb(II,IV). Changes in ambient chemistry can, however, bring about the solubilization and mobilization of these toxic metals. Our research examines these processes, emphasizing how changes in the chemical nature and quantity of natural organic compounds cause toxic metal mobilization. To begin our work, toxic metals were equilibrated with MnO₂(s) particles in suspension for 17 hours under oxygenated conditions. Adsorption affinity decreased in the following order: Co,Cu>Ni. Low molecular weight organic complexing agents and reducing agents were selected for study that have either been identified in soils and sediments, or are known to be produced by microorganisms. Above pH 6, 100 micromolar oxalate acts as a complexing agent, bringing about the release of adsorbed toxic metals, by leaving the host MnO₂ particles intact. The total amount of toxic metals released is related to the stability constant for metal-oxalate complex formation. Below pH 6, oxalate acts as a complexing agent and a reducing agent. Reduction of MnO₂ to Mn⁺⁺ causes toxic metal release through two indirect mechanisms: (1) Loss of host oxide surface area by dissolution, and (2) production of Mn⁺⁺, which displaces adsorbed toxic metals at available surface sites. Other low molecular weight compounds include pyruvate (acting only as a reducing agent), and citrate (acting as both, complexing and a reducing agent). Natural organic matter (NOM) samples from southern U.S. coastal swamps contain a complex mixture of low, medium, and high molecular weight molecules that differ in the capacity to reduce a complex metal. Addition of NOM brought about release of adsorbed toxic metals and reductive dissolution of the host MnO₂ phase. Our ultimate goal is to improve our understanding of metal mobilization processes and improve predictions concerning mobilization rates when ambient geochemical conditions are changed. This should improve our ability to assess the impact of existing environmental contamination, develop methods of remediation, and develop guidelines for future metal disposal practices.