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201 - Precipitation and kinetics of mixed-metal solids in soils, sediments, and mineral systems: Implications for equilibrium speciation calculations

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Matthew Siebecker¹, mgs@udel.edu, *George Luther*¹, *Donald Sparks*²

¹ School of Marine Science and Policy, University of Delaware, Lewes, Delaware, United States; ² Department of Plant and Soil Sciences, University of Delaware, Newark, Delaware, United States

Abstract: The behavior of trace metals and metal contaminants, in terms of their sorption, redox, and precipitation reactions, is critical for remediation of contaminated soils and in modeling natural geochemical cycling in sediments. These reactions often produce mixed metal solids which can have solubility product constants markedly different than pure metal solids. Solid phases influence metal speciation and transport, and their formation can be kinetically fast. For example, an important redox reaction with respect to soils and marine sediments is the cycling of reduced iron and manganese oxides. During this reaction, mixed metal solid phase Fe/Mn clays can form. Many types of clays in soils and sediments are mixed metal minerals and not pure metal. Another example is environmentally relevant mixed metal layered double hydroxides (LDHs), which can form in soils contaminated with nickel and zinc. LDHs can sequester metals in the solid phase, thus limiting their mobility in the soil solution. The solubility product constants of mixed metal solids are often absent from chemical equilibrium modeling databases commonly used for geochemical calculations. This presents a problem when trying to model chemical speciation of metals. Lastly, apart from rapid inorganic precipitation, iron and manganese can undergo biologically mediated redox reactions to produce solid phase precipitates. In both fresh and saltwater environments, reduced iron can be metabolized for energy by iron oxidizing bacteria. So, their common occurrence in various environmental settings, their fast kinetics in both inorganic and biological reactions, and their absence of solubility data from modeling databases, make mixed metal solids important to reconsider during equilibrium based modeling of metals

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