

LEAD COMPETITION IN CLAY-OXIDE MIXED SYSTEMS: AN XAFS ANALYSIS

T.E. ALCACIO¹, G.M. LAMBLE², A.M. SCHEIDEGGER¹, and D.L. SPARKS¹

¹Department of Plant and Soil Sciences, University of Delaware

²Brookhaven National Laboratory

One of the most significant mechanisms for removing metals from aqueous systems is through metal sorption onto mineral surfaces¹. With the application of modern synchrotron radiation to Extended X-ray Absorption Fine Structure (XAFS) analysis, our understanding of determining whether metals retain their hydration sphere and form outer-sphere complexes or shed part of it and form inner-sphere complexes, has evolved. Such studies have been particularly useful in characterizing single metal-mineral adsorption interactions, however, most environmental systems whether aquatic or terrestrial, are heterogeneous and have a myriad of solid phases present².

In this study, pyrophyllite (a 2:1 clay mineral lacking isomorphous substitution), gibbsite (an aluminum hydroxide) and mixtures of both minerals were equilibrated with Pb²⁺ to produce solid concentrations ranging from 2000-35,000 µg Pb/g solid. X-ray Absorption Fine Structure Spectroscopy was then used to determine the local chemical environment of the Pb treated individual minerals and their mixtures. The radial distribution function (RDF) for the individual gibbsite shows the appearance of a first and a second coordination shell. These distances are comparable to bond distances expected for Pb-O and Pb-Pb, respectively. However, the pyrophyllite which has nearly a 4 times greater surface area shows only one peak and no second coordination shell. When individual gibbsite and pyrophyllite samples ($\Gamma = 3.47$ and $1.73 \mu\text{mol m}^{-2}$ respectively) are dried and mixed together, the spectrum of the mixed component system agrees well with the prominent features displayed by the two individual spectra components. These results suggest that XAFS can be used to differentiate sorption modes in heterogeneous systems.

¹M.F. Hochella and A.F. White, in Mineral-Water Interface Geochemistry, edited by M.F. Hochella and A.F. White (Mineralogical Society of America, Washington DC, 1990).

²V.S. Tripathi et. al., Measurements of Metal Adsorption in Oxide-Clay Mixtures: "Competitive-Additivity" Among Mixture Components, in Scientific Basis for Nuclear Waste Management XVI, edited by C.G. Interante and R.T. Pabalan (Materials Research Society, Pittsburgh, P.A., 1993)