

Phosphate Adsorption in Mixed Mineral Systems

N. Khare and D.L. Hesterberg (North Carolina State U.)

Beamline(s): X19A

Introduction: Many agricultural fields contain excessive levels of soil phosphorus relative to crop needs. Runoff from these fields may cause deterioration of surface water quality. Hence, long term environmental stability of P in soils must be assessed. Soil phosphorus speciation information with regards to its various adsorbed and precipitated forms is critical in predicting the effects of pH, redox potential, and concentrations and can provide optimal P management in soils. Hesterberg et al., (1999) [1] identified unique distinguishing features in P K-XANES (X-ray absorption near edge structure) spectra of metal phosphates and phosphate adsorbed on Fe-oxide minerals, indicating the possibility of speciating phosphate in mixed systems. In this study, we used phosphorus K-XANES analysis to try to speciate phosphate and hence, assess the distribution of phosphate between Fe- and Al-hydr(oxide) minerals in mixed-mineral systems.

Methods and Materials: Phosphate was adsorbed at levels between 5 and 500 mmol/kg to single- and mixed mineral systems containing goethite ($S = 155 \text{ m}^2/\text{g}$) and gibbsite ($S = 54 \text{ m}^2/\text{g}$) at pH 6.

Results: P K-XANES spectra of aqueous PO_4 adsorbed on goethite or gibbsite, and in mixed (40:60) goethite/gibbsite systems normalized at the white line peak showed diminishing shoulder intensity and a shift in white line peak to higher energies with increase in phosphate concentration. Because P K-XANES spectra varied with the amount of adsorbed phosphate, single-mineral systems containing different levels of adsorbed phosphate were used as standards in linear combination fitting to determine the distribution of phosphate between each mineral in the mixed system. However, as shown in Figure 1., similar concentration dependent spectral features of P adsorbed on goethite and P adsorbed on gibbsite diminished the power of XANES to quantify the distribution of PO_4 in the mixed-mineral systems through linear combination fitting.

Conclusions: Similar concentration dependent features in normalized P K-XANES spectra of goethite and gibbsite may indicate similar phosphate bonding configuration on these minerals.

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Reference:

[1] Hesterberg, D.L., W. Zhou, K.J. Hutchison, S. Beauchemin, and D.E. Sayers, "XAFS study of adsorbed and mineral forms of phosphate", *J. Synchrotron Radiation*. Volume 6, pp. 636-638, 1999.

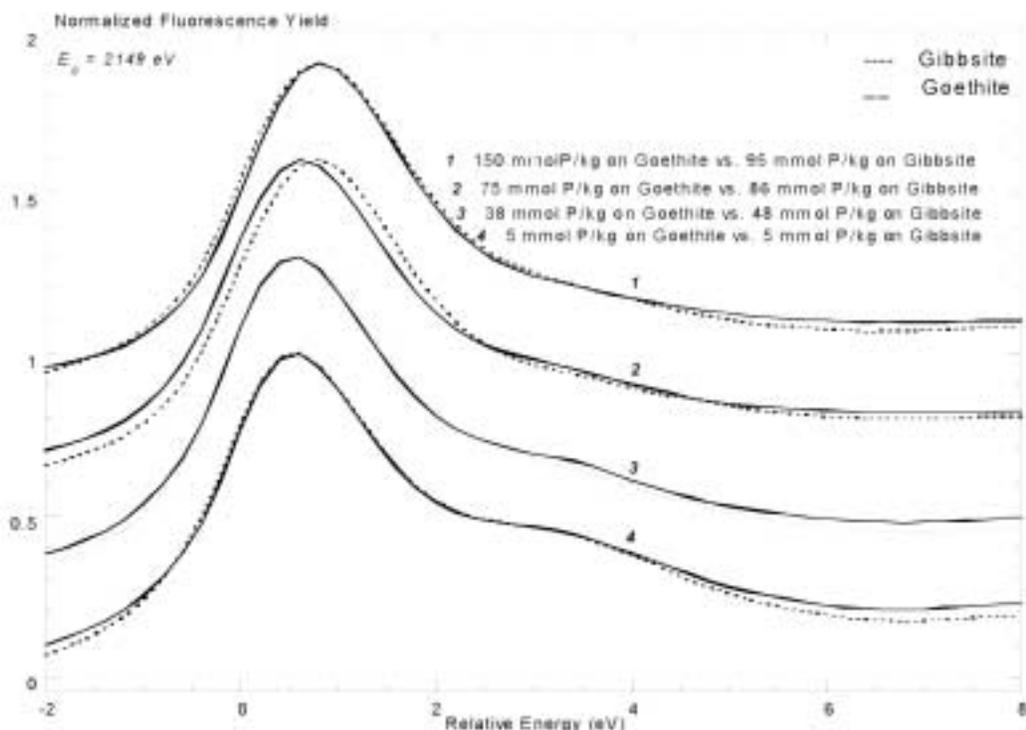


FIGURE 1. Stacked P K-XANES spectra of phosphate adsorbed on goethite and gibbsite systems at pH 6 normalized to the maximum fluorescence at 1-2 eV relative energy. The spectra of phosphate on goethite and phosphate on gibbsite showed similar concentration dependent features.