

Organic Acid Promoted Phosphorus Dissolution in Mineral-Mixtures: Implications for P Bioavailability

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Organic acid promoted phosphate dissolution is hypothesized to be the primary biogeochemical mechanism making mineral-soil phosphate available. This mechanism has direct implications for understanding biogeochemical cycling of phosphorus (P) and its impact on carbon sequestration, and global climate change. However, its current understanding is limited by the lack of molecular scale characterization of P solid state speciation in pertinent systems. The goal of this research was to determine the quantitative speciation of phosphate pre- and post-organic acid promoted dissolution in model mineral systems as a function of pH. Mineral systems include mixtures of sorbed and precipitated phases similar to phosphorus (P) sorbents in soils, ferrihydrite (FeOOH), boehmite (γ -AlOOH) and hydroxyapatite [$\text{Ca}_5(\text{PO}_4)_3 \cdot 5\text{H}_2\text{O}$]. Phosphorus K-XANES spectra of P-associated with Fe, Al, and Ca show unique spectral signatures for mineral-associated P, allowing for its quantitative speciation in model and natural systems. P K-XANES fitting results show that irrespective of initial preferential P association with Fe- or Al-based minerals, P preferentially dissolves from Al-based minerals and adsorbs on Fe-based mineral phases at acid pH (Fig. 1). A reverse trend is observed at alkaline pH (Fig.1).

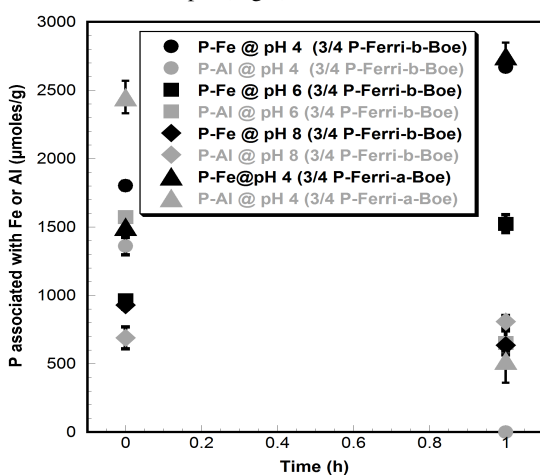


Fig.1: Molecular P speciation in binary mixtures of ferrihydrite-a/ferrihydrite-b of differing crystallinity and boehmite as a function of pH as quantified LCF fitting of XANES spectra.