

Do iron(II) phosphates control phosphate solubility in anoxic soils and sediments?

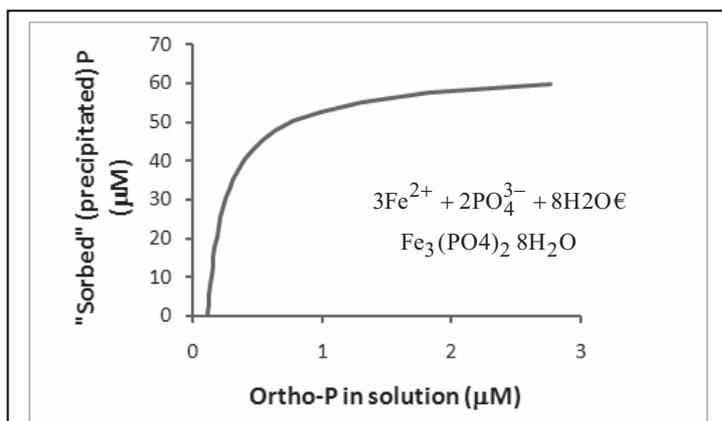
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Investigations of phosphate retention in lowland soils and lake sediments show highly contrasting results ranging from high net P retention to substantial P release as soil/sediment samples become increasingly anoxic. Reductive dissolution of Fe^{III} oxides causes release of P. However, in most cases the released P is not transferred to the solution phase, but sorbs to the remaining, non-reduced Fe^{III} oxide fraction, Al oxides, and silicate clays, or alternatively phosphate may precipitate e.g. as Fe^{II} phosphates (e.g. vivianite, Fe₂(PO₄)₃·8H₂O).

We are currently evaluating the role of vivianite in these environments. Evidently, for pore water in equilibrium with vivianite, the total ortho-P concentration will be strongly depending on the concentration of Fe²⁺, and pH, and the presence of phosphate complexing metals.



MINTEQ modelled ortho-P "sorption isotherm" for a system at equilibrium with vivianite. pH 7.0, P_{CO₂} 0.00036 atm, and total initial solution concentrations of Fe²⁺, Ca²⁺, Mg²⁺ and Cl⁻ of 200, 500, 100 and 1000 µM, respectively.

Assuming equilibrium and that vivianite is the only phase causing P retention then an apparent "sorption isotherm" can be constructed, demonstrating that vivianite can control ortho-P concentrations at a very low level.

A field investigation is being performed where pore water from a waterlogged histosol with a subsurface vivianite-containing horizon is being sampled. Horizon Fe^{II} solution concentrations range between 40 and 800 µM, and pH is close to 7. Ortho-P solution concentrations in the vivianite-

containing horizon range between 0.2 and 0.6 µM while concentrations from other anoxic and oxic horizons below and above are several times higher. Similarly, for a lake sediment (lake Ørn Sø, Demark) containing vivianite total ortho-P concentrations vary between 0.2 and 1.2 µM during winter, and with dissolved Fe²⁺ concentrations between 200 – 500 µM, and pH around 7.2.

For the vivianite-containing soil horizon and for the lake sediment, equilibrium computations including the concentrations of all main cations and anions show that the saturation index for vivianite is close to zero indicating that ortho-P concentrations are in equilibrium with and controlled by vivianite in these sediment and soil materials, which may strongly limit the solubility of ortho-P.