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Redox effects on phosphorus release from goethite under oxic conditions

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Oxic soils dominated by iron minerals are widespread but low bioavailability of phosphorus (P) in these soils limit plant uptake and growth. This is due to the immobilization of free P in soil from the formation of strongly bounded iron (Fe)-P complexes [1] however typically ignore the role of redox processes. The aim of this study is to report the influence of redox on P binding and solubilization by goethite under oxic conditions.

Goethite was loaded with P at rates of 100mmol/L to 40g of goethite and subjected to redox potentials ranging from -100mV to -300mV below ambient under oxic conditions. Redox potentials were maintained using a 630D CH Instrument electrochemical analyser and experiments conducted in electrochemical cells with a vitreous carbon working electrode, platinum counter electrode and Ag/AgCl reference electrode. pH was also varied from 5.5-8.0. Current responses were measured and total P concentration in solution observed up to 120 minutes using the molybdenum blue method. A DGT method based on a zirconium oxide binding gel was also used to assess the lability of the P species in solution

P was released from goethite into solution under mildly reducing conditions at an optimum pH of 6.5 and -300mV as shown in the figure below. However, filtration experiments suggest that this solution P was colloidal rather than orthophosphate. It is theorized that electrochemical processes may have reworked the P. Initial results reporting measurable solubilized P from the reductive dissolution of goethite at oxic conditions has potential impacts in aerobic P deficient soils however, an understanding of the bioavailability and state of P through DGT filtration and characterisation experiments is to be the next step.

[1] Chacon, N. *et al.* (2006) “Iron reduction and soil phosphorus solubilization in humid tropical forests soils: The roles of labile carbon pools and an electron shuttle compound,” *Biogeochemistry*, 78(1), pp. 67–84.