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Enrichment of Phosphate on Ferrous Iron Phases during Bio-Reduction of Ferrihydrite

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ABSTRACT

The reduction of less stable ferric hydroxides and formation of ferrous phases is critical for the fate of phosphorus in anaerobic soils and sediments. The interaction between ferrous iron and phosphate was investigated experimentally during the reduction of synthetic ferrihydrite with natural organic materials as carbon source. Ferrihydrite was readily reduced by dissimilatory iron reducing bacteria (DIRB) with between 52% and 73% Fe(III) converted to Fe(II) after 31 days, higher than without DIRB. Formation of ferrous phases was linearly coupled to almost complete removal of both aqueous and exchangeable phosphate. Simple model calculations based on the incubation data suggested ferrous phases bound phosphate with a molar ratio of Fe(II):P between 1.14 - 2.25 or a capacity of 246 - 485 mg · P · g^{-1} Fe(II). XRD analysis indicated that the ratio of Fe(II): P was responsible for the precipitation of vivianite ($Fe_3(PO_4)_2 \cdot 8H_2O$), a dominant Fe(II) phosphate mineral in incubation systems. When the ratio of Fe(II):P was more than 1.5, the precipitation of Fe(II) phosphate was soundly crystallized to vivianite. Thus, reduction of ferric iron provides a mechanism for the further removal of available phosphate via the production of ferrous phases, with anaerobic soils and sediments potentially exhibiting a higher capacity to bind phosphate than some aerobic systems.

KEYWORDS

Phosphate; Iron Reduction; Ferrihydrite; Ferrous Iron; Vivianite

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