

Dissolution of iron oxides in the presence of ligands and reductants

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The dissolution of iron oxides in natural systems is controlled by reductive and ligand-controlled processes. Their mechanisms have been elucidated in model systems and their effects have been studied in complex natural matrices. Microorganisms and plants are taking advantage of the reactivity of ligands and/or reductants for the acquisition of iron as a nutrient in oxic aqueous or terrestrial systems in the neutral or alkaline pH ranges.

A key problem of biological iron mobilization using reductants is the extremely fast Fe(II) re-oxidation rates typically observed in the neutral to alkaline pH-range, which seem to preclude transport of the reduced iron toward microbial or root surfaces unless the Fe(II) becomes chemically stabilized or re-oxidized Fe(III) remains in a soluble complex. However, previous and ongoing research of our group has demonstrated, that low transient Fe(II) concentrations have a catalytic effect on non-reductive ligand-controlled dissolution.

In this presentation we will summarize key findings of our research focusing on the interplay of ligand controlled and reductive processes. In our studies we used a range of synthetic and biogenic ligands (e.g., synthetic ligands used in agricultural iron fertilization, microbial and plant siderophores) and biogenic reductants. In our most recent work we studied a class of biogenic compounds exuded by iron limited plants that can both reduce and ligate iron. We studied their effect on the dissolution of various iron oxides and on iron mobilization in complex soils. The advances and limitations of our current conceptual understanding of dissolution mechanisms in the presence of ligands and reductants as well as their significance in natural systems are discussed. Funding for this work is provided by the Austrian FWF grant I 2865-N34