Microbially mediated geochemical phosphate scavenging, retention and recycling in oligotrophic environments

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Early earth conditions were probably such that there was no lack of C, H, O, N and S containing precursor compounds, but it remains unresolved where the phosphorous compounds came from and how P could be concentrated from dilute solutions to amounts needed for the synthesis of all the essential phosphate-containing biomolecules. Jöri Lake XIII is a remote high-mountain aquatic ecosystem, which has a naturally low nutrient input and an active iron cycle. It is excellently suited to study the role of geochemical and microbiological processes in nutrient accumulation from highly dilute aquatic environments and to derive concepts about nutrient scavenging as a prerequisite for early ecosystem evolution. The coupled geobiological cycles of Fe and P in Jöri lake are summarized in figure 1.
Community analysis revealed a large diversity of trophic extremophiles, which thrive in low nutrient water, ice and snow habitats, which confer the ability to mobilize phosphate from amorphous ferric oxide coated surfaces.

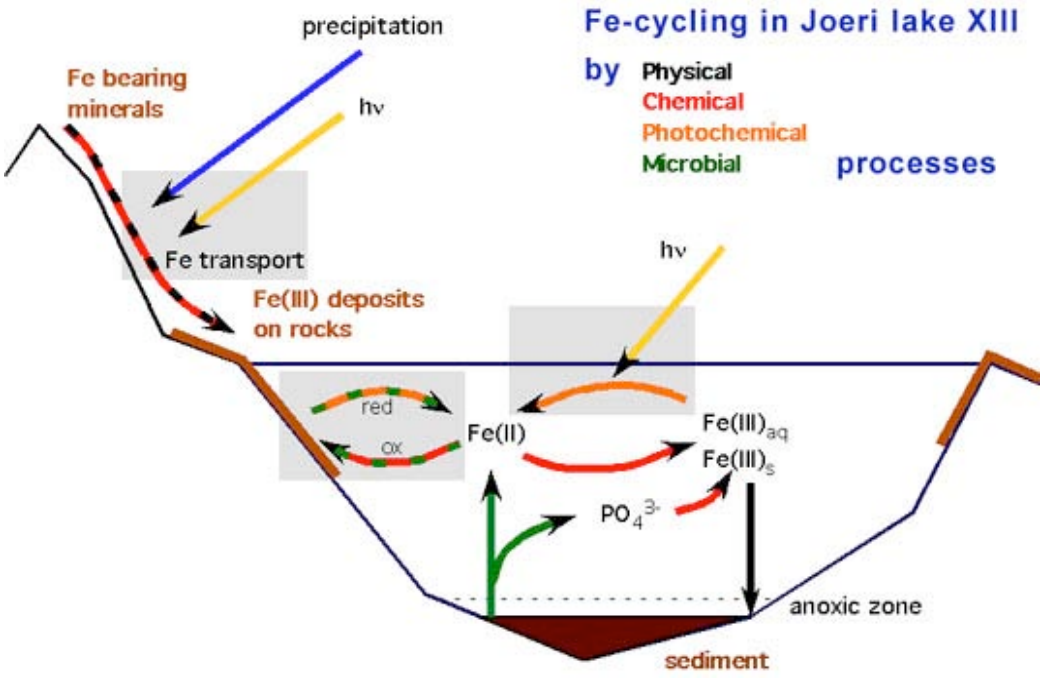

Figure 1: Proposed iron cycle in Jöri lake XIII: The iron cycle consists of several parts. Fe (III) is microbially reduced in the anoxic sediment to Fe (II), which is reoxidized by anaerobic phototrophs to Fe (III). Released Fe (III) is less soluble than Fe (II) and ferrihydrite precipitates. In the chemical part of the cycle soluble Fe (III) is reduced by photo reduction. The formed Fe (II) is reoxidized to Fe (III) by dissolved oxygen. Because of its low solubility Fe (III) precipitates as ferrihydrite and sediments with and without entrapped phosphate.

Key words:
early earth nutrient scavenging, phosphate limitation, iron cycle, oxyanion incorporation, ferric iron reducing bacteria, ferrous iron oxidation, trophication, dilute nutrient concentration