# Microbial iron(II) oxidation in littoral freshwater lake sediments; Competition between phototrophic versus nitrate-reducing iron(II)-oxidizers

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The temporal and spatial distribution of microbial iron redox transformations are determined by local geochemical conditions and the resident microbial diversity. In the anoxic part of the top layer of littoral freshwater lake sediments, nitrate-reducing and photoferrotrophic microorganisms compete for the same electron-donor, i.e. reduced iron. Though a conceptual framework for biogeochemical iron cycling has been proposed [1], it is not yet empirically understood how these microbes co-exist in the sediment, what their spatial distribution is relative to one another and what role they play in the overall iron cycle. In this study, freshwater littoral lake sediment from Lake Constance was incubated in microcosm experiments with various additives to stimulate microbial photoferrotrophic and nitrate-reducing iron (II) oxidation in order to distinguish between the two processes and assess their individual contributions to the sedimentary iron cycle. One set was incubated under constant light, whilst a parallel set was incubated in the dark at 23°C. Additionally, a high-resolution MPN depth profile was performed for iron (II)-oxidizing organisms utilizing light or nitrate to reveal their spatial distribution in the natural sediment. These experiments combine microbial and geochemical techniques to provide key information needed not only to determine the contribution of microbial activity to the overall iron oxidation budget and their spatial distribution, but also to define the role of geo (photo)chemical iron conversion rates and its general importance in littoral freshwater lake sediments.

[1] Schmidt *et al*. (2010) *Environmental Chemistry* **7**, 399–405.

# Unraveling microbes-minerals interactions in the deep biosphere

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Subsurface environments harbor diverse and active microbial populations that influenced the Earth's chemistry throughout geological times by mediating elemental fluxes from the lithosphere to the oceans and atmosphere. However, the exploration of their metabolic diversity, energy sources, and biogeochemical transformations at the appropriate scale remains highly challenging, especially within hard rocks. We present here dedicated cutting-edge approaches combining molecular labelling (as fluorescence *in situ* hybridization and immunodetection) with an array of high-resolution techniques (coupled confocal laser scanning microscopy and Raman spectroscopy, transmission and scanning electron microscopies, synchrotron-based X-ray microimaging). Altogether they allow localizing specifically individual prokaryotic cells, investigating their phylogenetic affiliation at the micrometric scale while characterizing concomitantly the nature and the stucture of their microhabitats and past interactions (i.e. mineral dissolution and metabolic byproducts such as biomineralizations). Our ability to reveal chemical, mineralogical, genetic and metabolic diversity in subsurface environments will be illustrated by integrated field and laboratory investigations. Special attention will be dedicated to hydrogen-driven chemolithoautotrophic ecosystems associated with ultramafic rocks from the oceanic lithosphere, in the double fundamental perspective: to explore analogs for early biological systems on the primitive Earth or other planetary bodies, and for industrial purposes being a major target for $CO_2$ geological storage where microbial activity allow enhancing carbonation processes and reducing the energetic balance.