Coupling of Fe and N cycles by nitrate-reducing Fe(II)-oxidizing bacteria in freshwater sediments

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The coupling of nitrate reduction to Fe(II) oxidation is a widely found process that has been reported among others from marine as well as freshwater sediments and agricultural soils. Both, Fe and N cycles, have significant environmental impacts. Iron is the most abundant redox active transition metal in soils and sediments and is essential for most living organisms as a trace element. Furthermore iron minerals strongly influence the mobility and solubility of nutrients as well as toxins or heavy metals. Nitrogen species include the important nutrient NO_3^- as well as the greenhouse gas N_2O. The coupling of Fe and N consequently impacts local as well as global scale processes.

The cycling of iron in sediments is to a great extent mediated by Fe(II)-oxidizing and Fe(III)-reducing bacteria. Very abundant among the Fe(II)-oxidizing bacteria are nitrate-reducing Fe(II)-oxidizers that couple the oxidation of ferrous iron to the reduction of nitrate. This coupling has been subject of various studies as it remains questionable whether nitrate-reducing Fe(II)-oxidizing bacteria are able to oxidize Fe(II) enzymatically, or whether the Fe(II) oxidation is an abiotic process driven by the microbial production of nitrite during heterotrophic denitrification [1]. So far, this process has been investigated mainly in bacterial (enrichment) cultures. Here we investigate the coupling of nitrate reduction and Fe(II) oxidation in environmental samples. We determined the distribution and abundance of nitrate-reducing iron-oxidizing and heterotrophic denitrifying microorganisms using cultivation-based techiques such as most-probable-numbers as well as cultivation-independent molecular approaches such as qPCR in littoral freshwater sediment from Lake Constance, Germany. Fe and N redox transformations were quantified in microcosm experiments, mimicking sedimentary geochemical conditions. This allowed the monitoring of Fe and N cycling in dependence of the presence of different concentrations of nitrate and Fe(II).

[1] Klueglein & Kappler (2013) *Geobiology* **11**, 180-190.