Nitrate-dependent microbial oxidation of Fe(II) in stratified freshwater lakes

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Iron-oxidizing nitrate-reducing bacteria are involved in iron and trace element cycling in diverse ecosystems such as marine and freshwater sediments, aquifers, soils or rice paddies. Furthermore, it has been proposed that they contributed to the deposition of banded iron formations (BIF) in the ferruginous water column of the Neoarchean ocean (2.8 to 2.5 Ga ago) when nitrate became more available on Earth. To date, however, evidence for the presence and activity of nitrate-dependent iron-oxidizing bacteria in water-column ecosystems is scarce. We used high resolution physico-chemical profiling, ^{14}C-bicarbonate incubation experiments, and iron-oxidation incubations to explore the activity of iron-oxidizing nitrate-reducing bacteria in the iron-rich meromictic Lake La Cruz (Spain) where anoxygenic phototrophic Fe(II)-oxidation has been detected previously [1, 2]. Moreover, ^{15}N-label incubation experiments were set up to trace biological/chemical N-transformations in presence of Fe(II). The results show that nitrate-dependent Fe(II) oxidation was operating in the chemocline of this ferruginous meromictic lake. The natural microbiota demonstrated Fe(II)-stimulated autotrophy and Fe(II)-oxidation only in presence of nitrate. The abundance of nitrate-dependent iron-oxidizers was estimated by MPN cultivation and several Fe(II)-oxidizing nitrate-reducing enrichment cultures were established. Moreover, MPN counts of nitrate-dependent iron-oxidizers in the seasonally anoxic eutrophic Lake Loclat and the sulfidic meromictic Lake Cadagno suggest that the potential for nitrate-mediated Fe(II)-oxidation may be more widespread than previously thought.

[1] Walter et al. (2014) Phototrophic Fe(II)-oxidation in the chemocline of a ferruginous meromictic lake. *Front. Microbiol.* 5:713. [2] Camacho et al. (2017) Photoferrotrophy: remains of an ancient photosynthesis in modern environments. *Front. Microbiol.* *8*, 323.