Interrelation, competition and environmental consequences of microaerophilic, nitrate-reducing and phototrophic Fe(II) oxidation in freshwater and marine sediments

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Iron is abundant in freshwater and marine sediments where it can be biogeochemically cycled between its divalent and trivalent redox state (1). The neutrophilic microbiological Fe cycle involves Fe(III)-reducing and three different physiological groups of Fe(II)-oxidizing microorganisms, i.e. microaerophilic, anoxygenic phototrophic, and nitrate-reducing Fe(II)-oxidizers. However, it is unknown whether all three groups of Fe(II)-oxidizers co-exist in one habitat or how they are spatially distributed with relation to gradients of O_2, light, nitrate and Fe(II). We investigated Fe(II)-oxidizers in both freshwater and marine sediments at Lake Constance (Germany) and Aarhus Bay (Denmark), respectively, by cultivation, most probable number (MPN) studies and qPCR (2). We isolated representatives of all three metabolic types of Fe(II)-oxidizers and are now using a combination of batch microcosms, core incubations, and chemostat experiments to study their spatial distribution, their activities and, in particular, their interrelation and competition. Additionally, we are investigating the environmental consequences of their activities for Fe(III) mineral formation and the fate of trace metals (Ni, Co) in the sediment, as well as the role of these microbial processes in the emission of greenhouse gases. The ultimate goal of this work is to determine the importance of microbial Fe(II) oxidation in both modern and ancient aqueous habitats.

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(2) Melton, E.D., Swanner, E.D., Behrens, S., Schmidt, C., Kappler, A. (2014) The interplay of microbially mediated and abiotic reactions in the biogeochemical Fe cycle. Nat. Rev. Microbiol., 12, 797-808.