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Contribution of Microaerophilic Iron(II)-Oxidizers to Iron(III) Mineral Formation

Markus Maisch¹, Ulf Lueder¹, Katja Laufer², Caroline Scholze², Andreas Kappler^{1,2}, and Caroline Schmidt^{1,2}

¹Geomicrobiology, Center for Applied Geosciences, University of Tübingen, Germany

²Department for Bioscience, Aarhus University, Denmark

Abstract:

Neutrophilic microbial aerobic oxidation of ferrous iron [Fe(II)] is restricted to pH-circumneutral environments characterized by low oxygen where microaerophilic Fe(II)-oxidizing microorganisms successfully compete with abiotic Fe(II) oxidation. However, accumulation of ferric (bio)minerals increases competition by stimulating abiotic surface-catalyzed heterogeneous Fe(II) oxidation. Here, we present an experimental approach that allows quantification of microbial and abiotic contribution to Fe(II) oxidation in the presence or initial absence of ferric (bio)minerals. We found that at 20 μM O_2 and the initial absence of Fe(III) minerals, an iron(II)-oxidizing enrichment culture (99.6 % similarity to *Sideroxydans* spp.) contributed 40 % to the overall Fe(II) oxidation within approximately 26 h and oxidized up to 3.6×10^{-15} mol Fe(II) cell⁻¹ h⁻¹. Optimum O_2 concentrations at which enzymatic Fe(II) oxidation can compete with abiotic Fe(II) oxidation ranged from 5 to 20 μM . Lower O_2 levels limited biotic Fe(II) oxidation, while at higher O_2 levels abiotic Fe(II) oxidation dominated. The presence of ferric (bio)minerals induced surface-catalytic heterogeneous abiotic Fe(II) oxidation and reduced the microbial contribution to Fe(II) oxidation from 40 % to 10 % at 10 μM O_2 . The obtained results will help to better assess the impact of microaerophilic Fe(II) oxidation on the biogeochemical iron cycle in a variety of environmental natural and anthropogenic settings.

Keywords: aerobic oxidation, abiotic Fe(II) oxidation, ferric (bio)minerals, microaerophilic, micro-oxic conditions, O_2 gradient