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Elucidating microbial and abiotic iron and silica mineral precipitation relevant for Banded Iron Formations (BIFs) in column experiments

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BIFs are a window into the geological and biological history of the early Earth (3.8–1.85 Ga) [1]. The mechanisms leading to the deposition of BIFs and especially the role of microbes in mineral (trans-)formation during sedimentation remain a topic of research. The Fe-rich layers traditionally were ascribed to abiotic Fe(II) oxidation by O_2 produced by cyanobacteria in ancient oceanic photic zones [2]. More recently it was hypothesized that anoxygenic photoautotrophic Fe(II)-oxidizing bacteria (photoferrotrophs) could have also been involved in the process [3,4]. Photoferrotrophs could have directly oxidized Fe^{2+} in the water column and coupled this to the fixation of CO_2 using solar energy without any need for O_2 availability [4]. Many aspects of the biology of early cyanobacteria and photoferrotrophs seem to agree with an enhanced role of the latter that would have had a competitive advantage being better poised to benefit from upwelling P-rich deep waters, given their adaptation to low-light conditions and since cyanobacteria have higher P requirements. The goal of our project, therefore, is to quantify the relative contributions to the Fe(II) oxidation of each metabolism and whether these could have coexisted in a redox-stratified water column and both contributed to Fe(II) oxidation at the same time. Therefore, we have prepared a large column (1.8 m long) experiment incubating cyanobacteria (*Synechococcus* PCC 7002) and/or photoferrotrophs (*Rhodovulum iodosum*) under simulated Archean ocean conditions with continuous Fe and silica inflow. We will quantify the evolution of dissolved Fe, Si and organic C over time and analyze the mineral particles formed in the water column as in the sedimented. Finally, controlled temperature changes will simulate natural variations in the Precambrian ocean, hypothetically leading to alternating precipitation of Fe(III)- and silica-rich layers. While previous microbial studies have focused on either photoferrotrophs or cyanobacteria, in this experiment we will co-cultivate both autotrophs to elucidate their contribution to Fe(II) oxidation and BIF Fe(III) mineral deposition.

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