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Finding what is absent – Organic carbon cycling in simulated early environments

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Banded iron formations (BIFs) are marine (bio)chemical sedimentary deposits which formed between 3.8 and 1.85 Ga and are characteristically rich in silica and iron. Often cited genetic processes include; (1) microbial Fe(II) oxidation, e.g. by anoxygenic photoautotrophic Fe(II)-oxidizing bacteria (photoferrotrophs) or via oxygen produced by early cyanobacteria, and (2) dissimilatory microbial Fe(III) reduction. However, while there are strong arguments for a microbial origin of BIFs, they have conspicuously low organic carbon (C_{org}), which has been used to argue against the biogenicity of BIFs.

While extensive research has focused on identifying the primary BIF mineral phases, the fate of C_{org} in BIFs remains understudied. Therefore, the aim of our study was to shed light on the potential fate of microbial biomass formed during the genesis of BIFs. Specifically, we focused on the following questions: (1) Would early C_{org} degraders have been able to access the biomass of planktonic primary producers? (2) If yes, which metabolic products were formed and were these formed in sufficient quantities to fuel connected heterotrophic microbial processes? (3) Would Fe(III) (oxyhydr)oxides, commonly associated with such microbial biomass, have provided protection against degradation?

We performed co-cultivation experiments with the model photoferrotroph *Rhodovulum iodosum* and a novel C_{org}-degrading enrichment culture (containing various families known for hydrolysis and/or fermentation) either in the absence (grown on H_2) or presence of Fe(III) (oxyhydr)oxides (grown on Fe^{2+}). Preliminary results suggest that, even though the photoferrotroph biomass was accessible to the C_{org}-degrading culture in both instances, there were differences in the onset of C_{org} degradation and the quantity of metabolites produced. Specifically, C_{org} degradation in the Fe(III) (oxyhydr)oxide-containing experiments lagged behind the biomass-only experiments by approximately 80 days. Further, volatile fatty acids such as acetic acid were produced in much lower quantities (10s instead of 100s of µM) in the presence of Fe(III) (oxyhydr)oxides.

In conclusion, Fe(III) (oxyhydr)oxides provided some protection against degradation, but *R. iodosum* biomass remained bioavailable, producing enough metabolites in all setups to fuel other microbial processes. However, C_{org} degradation in our experiments was incomplete, and therefore additional processes are required to explain the absence of C_{org} from BIFs.