Identity and Abundance of Iron- and Sulfur-Metabolizers in a Paleoproterozoic Ocean Analogue

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The Great Oxidation Event (GOE) (2.4-2.3 Ga) was a key turning point in Earth's surface redox evolution and the diversification of life. Early microbial communities had to deal with a developing ocean redox stratification and the transition of seawater from dominantly ferruginous (iron(II)-rich and anoxic) to euxinic (sulfide-rich and anoxic) and locally microoxic conditions. Among the most compelling questions that arise from the geochemical transition of Paleoproterozoic seawater are the composition of the microbial communities and whether iron- and sulfur-metabolizers could have coexisted in ferro-euxinic intermixed transition zones. Gaining information about the ancient biosphere from the rock record is challenging and a promising avenue is the use of modern model habitats that possess biogeochemical conditions similar to those thought to have existed on ancient Earth. However, only few such habitats are known so far.

Here we present geochemical, mineralogical, and microbiological data from the Arvadi Spring in Switzerland, a Paleoproterozoic ocean analogue. We show that microaerophilic iron(II)-oxidizers and sulphide-oxidizers represent the largest fraction of iron- and sulphur-metabolizers that co-exist with less abundant iron(III)-reducers, sulphate-reducers and phototrophic and nitrate-reducing iron(II)-oxidizers. 16S rRNA gene 454 pyrosequencing revealed sulphide-oxidizing *Thiothrix* species to dominate the spring microbial community on the genus level, supporting our cultivation-based results.

Collectively, our data implies anaerobic and microaerophilic iron- and sulphur-metabolizers to have co-existed in ferro-sulphidic transition zones of the Paleoproterozoic ocean, where they sustained continuous cycling of iron and sulphur compounds.