Experimental insights into ancient biogeochemical Fe-cycling and Fe-biosignature formation

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Our knowledge on ancient Fe-cycling is vague due to the incomplete and metamorphosed nature of the geologic record that conventionally serves as primary source of information. The use of modern analogue habitats that resemble ancient ocean composition coupled with lab-based simulation experiments can help resolve important questions on ancient processes. Here we present two different microcosm approaches that borrow potential to improve our understanding of the controls on ancient biogeochemical Fe-cycling and the formation of Fe-mineral products in form of twisted stalks that serve as biosignatures. Microcosms with samples from a modern analogue for ferro-euxinic ancient ocean zones, i.e. the Arvadi Spring in Switzerland, revealed the spatial separation of Fe(II) oxidation and Fe(III) reduction processes to oxic and anoxic niches, respectively. We showed that Fe(III) reduction was limited by the availability of organic carbon and contemporaneously proceeding sulfate reduction, whereas Fe(II) was mainly oxidized abiotically by oxygen. Assessing the relative contribution of microaerophilic Fe(II)-oxidizers to the net Fe(II)-Fe(III)-turnover has proven to be challenging in sedimentary microcosms. We describe an alternative microcosm approach using pure cultures of the extant microaerophilic Fe(II)-oxidizers *Mariprofundus* sp. DIS-1 and *Ghiorsea bivora* TAG-1 that were incubated with varying levels of oxygen and Fe(II). Our results provide valuable information on controls of microaerophilic Fe(II) oxidation and on Fe-biosignature formation mechanisms.