

A laboratory-scale column to investigate microbial processes in Fe(II)-rich upwelling systems

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The deposition of oxidized Fe to Precambrian Banded Iron Formations (BIFs) has classically been interpreted to reflect ferrous iron [Fe(II)] oxidation by molecular oxygen that was produced by cyanobacteria. Recent studies calculated that anoxygenic photoautotrophic Fe(II) oxidizing bacteria could also have played a major role in deposition of BIFs in a stratified ancient ocean, especially in Fe(II)-rich upwelling systems.

In order to investigate and analyze microbial processes in a laboratory-scale Fe(II)-rich upwelling system we designed a 50 cm long vertical flow-through column with anoxic, Fe(II)-rich medium of seawater salinity that is pumped into the bottom of the column at rates representative of upwelling to Archaen BIF basins [1]. The photic zone is simulated with a defined light source from the top, and by covering the sides of the column. Glassbeads (~ 0.5 mm diameter) fill the column to stabilize the geochemical gradient as with a pycnocline [2], and also serve to narrow the "photic zone" (i.e. by attenuating light). In-situ measurements can be conducted to quantify oxygen-concentration and distribution vertically through the column. Iron concentration and speciation can be analyzed by liquid samples, taken anoxically via sampling ports along the sides of the column. Aqueous samples can also be used to determine the density of microorganisms. Initial experiments documented the response of cyanobacteria *Synechococcus* PCC 7002 to sustained upwelling fluxes of Fe(II) and quantified Fe(II) oxidation rates induced by photo-synthetically-produced oxygen.

This laboratory-scale column therefore serves as proof-of-concept for an Archaen upwelling system and as a method to investigate microbial processes and geochemical patterns within these systems. Future experiments will incorporate more complex microbial communities (i.e. cyanobacteria, photoferrotrophs and/or microaerophilic Fe(II)-oxidizers), and we anticipate the column can be used to investigate other geochemical parameters, such as the fractionation of Fe isotopes in a stratified system.

[1] Konhauser et al. (2002), *Geology*. [2] Özsoy and Ünlüata (1997), *Earth Sci. Rev.*