Cyanobacteria and photoferrotrophs: together again?

ELIZABETH D. SWANNER[1*] AND ANDREAS KAPPLER[1]

[1]University of Tübingen, Center for Applied Geoscience (ZAG), Geomicrobiology, Tübingen, Germany. elizabeth.swanner@ifg.uni-tuebingen.de (* presenting author)

Phototrophs in a Ferrous Ocean

Anoxygenic phototrophs capable of metabolically oxidizing Fe^{2+} to Fe^{3+} are believed to be responsible for the deposition of mixed-valence Fe-containing Banded Iron Formations (BIF) in a Precambrian atmosphere of low O_2 [1]. The evolution of oxygenic photosynthesis by cyanobacteria has long been regarded as the primary mechanism for a rise in atmospheric O_2 in the Paleoproterozoic [2], and this O_2 would have further reacted with abundant aqueous Fe^{2+} to contribute to the deposition of BIF. As BIF were deposited across a wide range of Earth history and represent several distinct depositional settings, they potentially recorded changes in the makeup of the marine biosphere, particulalry among the anoxygenic photo(ferro)trophs and cyanobacteria. We ask what these changes were, and whether or not they are recorded in the style and substance of BIF deposition.

To address this, we report on our attempts to co-cultivate marine species of cyanobacteria and a photoferrotroph under conditions relevant to the hypothosized Precambrian ferrous ocean. Both strains will be independently evaluated to determine what chemical and physical factors imposed by changing ocean chemistry could have limited growth. These include light intensity, temperature and trace element availability. The results will be useful to compare with datasets reporting the calculated abundance of trace elements (e.g. Ni, Co) in the Precambrian ocean [3]. Then, the spatial distribution of trace metals and phosphorus to Fe and organic carbon from cell-mineral precipitates of Fe-containing co-culture experiments will be used for late-stage diagenesis experiments at temperature and pressure conditions observed in BIF to determine whether any trace element signatures associated with the phototrophic metabolisms in a ferrous ocean would be retained through time. A combination of fluorescence-based metal dyes in confocal microscopy and scanning transmission X-ray microscopy (STXM) will be used to assess these relationships both before and after simulated diagenesis.

Analogues for Precambrian Microbial Communities

As ferrous-rich marine environments today are scarce, analogue environments to study the phototrophic biosphere as occurred in the Precambrian and its implications for BIF are lacking. However, laboratory experiments are most useful if relevant to natural systems. Therefore we will compare the results of our data with the natural distribution of cyanobacteria and photoferrotrophs from a circumneutral Fe-rich freshwater lake. As most knowledge about photoferrotrophs is currently sourced from work with pure cultures, further molecular, chemical and cultivation-based studies of these organisms in natural environments is warranted.

[1] Kappler et al (2005) *Geology* **33**, 865-868. [2] Cloud (1968) *Science* **160**, 729-736. [3] Konhauser et al (2009) *Nature* **458**, 750-754.

An assessment of submarine groundwater discharge and its nearshore ecological impacts: Examples from the U.S. west-coast and Hawai'i

P.W. SWARZENSKI[1*], C.A. SMITH[2], P. M. GANGULI[3], J.A. IZBICKI[4] AND R.W. SHEIBLEY[5]

[1]USGS, Santa Cruz, CA (pswarzen@usgs.gov) (*presenting author)
[2]USGS, St. Petersburg, FL (cgsmith@usgs.gov)
[3]University of California, Santa Cruz, CA (pganguli@ucsc.edu)
[4]USGS, San Diego, CA (jaizbick@usgs.gov)
[5]USGS, Tacoma, WA (sheibley@usgs.gov)

The dynamic exchange of a coastal aquifer with sea water is a ubiquitous but still mostly inadequately quantified vector for nutrients and trace elements enroute to the sea. Biogeochemical reactions within this coastal aquifer/sea water mixing zone will transform many chemical species, including the redox sensitive- and microbially-mediated elements. As a result, this mixing zone can be a productive incubator zone for transformation products that rely on microbes or steep redox gradients. Geochemical and geophysical data from sites that extend from southern California to Puget Sound and Hawai'i will be used to assess submarine groundwater discharge (SGD) rates, scales, and constituent loadings. Unique geologic, climatic, and hydrologic characteristics define many west-coast U.S. and Hawaiian coastal systems. In these systems, the physical drivers and anthropogenic impacts on SGD are often unique and are assessed using a suite of naturally-occurring radionuclides (^{222}Rn and ^{223,224,226,228}Ra) and multi-channel electrical resistivity techniques. SGD is also evaluated as a sustained vector for nutrient (e.g., N and P) and trace element (e.g., Hg, U) loadings to nearshore environments and discussed in terms of ecosystem processes and impacts.