Constraining the role of anoxygenic phototrophic Fe(II)-oxidizing bacteria in the deposition of Banded Iron Formations

A. KAPPLER, N. R. POSTH, F. HEGLER AND I. KOEHLER

Geomicrobiology, Center for Applied Geosciences, University of Tuebingen, Sigwartsstrasse 10, 72076 Tuebingen, Germany (andreas.kappler@uni-tuebingen.de)

Banded Iron Formations (BIFs) are Precambrian sedimentary deposits of alternating iron and silica mineral layers. The mechanism of BIF deposition is still unclear. Early BIFs were likely deposited in an O_2-free environment, for which there have been two formation processes suggested. The first mechanism is the photooxidation of Fe(II) via UV light, which was recently found to have likely offered a negligable contribution to BIF formation. Here we focus on constraining the second anoxic mechanism; the biological oxidation of Fe(II) via anoxygenic Fe(II)-oxidizing photoautotrophs.

In order to find the limitations of photoferrotrophic BIF deposition, we take a holistic approach, investigating the oxidation of Fe(II) by modern Fe(II)-oxidizing phototrophs, the precipitation of Fe(III) (hydr)oxides, and the fate of the cell-mineral aggregates at the basin floor. Specifically, physiology experiments with Fe(II)-oxidizing phototrophs under various conditions of light intensity, pH, Fe(II) concentration and temperature allow us to determine the environmental limits of such a metabolism. We carry out precipitation experiments to characterize the sedimentation rates, composition and aggregate size. Finally, we simulate the diagenetic fate of these aggregates on the basin floor by placing them in gold capsules under temperature and pressure conditions relevant for the Transvaal Supergroup BIFs of South Africa. Recently, we have developed a tank simulating the Archean ocean in which the strains grow in continuous culture and collect the aggregates formed under various geochemical conditions.

Numerical modeling of Ca-enrichment on authigenic carbonate formation at mud volcanoes: A case study off Costa Rica

D. KARACA[1]* C. HENSEN[1,2] AND K. WALLMANN[1,2]

[1]SFB-574, University of Kiel, Wischhofstrasse 1-3, D-24148, Kiel, Germany (*correspondence: dkaraca@ifm-geomar.de)

[2]IFM-GEOMAR, Wischhofstrasse 1-3, D-24148, Kiel, Germany

The Costa Rican forearc is characterized by active fluid venting related to mud diapirism and volcanism. The peculiar situation at the latter sites is that Ca concentrations in the upward migrating fluids are well above seawater levels. In turn, these Ca-enriched fluids could offer a potential reason for widespread carbonate caps on top of the mounds. The main objective of our study is that to better constrain the impact of Ca-enrichment from fluid venting on calcium carbonate precipitation rates. Here, the numerical model is applied to investigate this relationship by application of a number of systematical variations. In addition we provide comprehensive results of turnover of methane, AOM-related authigenic carbonate formation and velocity of the rising fluids at six different stations off Costa Rica continental margin. Fluids of 3 of 5 sites (Quepos Slide, Culebra Fault, Mudpie) are enriched in calcium. In contrast, fluids of the other two sites (Mounds 11 and 12) are low in calcium.

Simulations with varying fluid flow rate and increased Ca concentrations in the ascending fluid demonstrate that the impact of Ca-enrichment on carbonate precipitation rate is significant. This effect is more pronounced at lower advection rates. Saturation state of upward migrating fluids is a sensitive parameter affecting calcium carbonate precipitation in surface sediments. At the active vent locations of Mounds 11 and 12 about 98% of the CH_4 is released into the bottom waters due to high advection rates (100-200 cm a^{-1}). The lower CH_4 turnover by AOM at Mound 11 and 12 also causes reduced alkalinity production hence retarded formation of authigenic carbonates. In comparison, moderate flow rates (0.1- 40cm a^{-1}) at Culebra Fault, Quepos Slide and Mudpie lead to reduced CH_4 output. Here, higher efficiency of AOM and Ca fluxes increase the calcium carbonate precipitation rates, thus higher Ca fluxes from below induce more precipitation of calcium carbonate.