Characterization of metabolically active microorganisms in an hydrothermal active field in the Okinawa Trough (IODP Exp. 331)

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The BGR project, as part of the post-cruise research of IODP Expedition 331, Deep Hot Biosphere, shall test the hypothesis that the quantitative microbial community composition and the cultivable microorganisms in hydrothermally influenced deeply-buried marine sediments are significantly different from those in cold and temperate deeply-buried marine sediments. The previously successfully applied molecular techniques real-time PCR (qPCR) and catalyzed reporter deposition - fluorescence *in situ* hybridisation (CARD - FISH) shall be used as well as cultivation and stable isotope-probing to proof the existence of a deep hot biosphere, to describe it and to isolate novel microorganisms. The domains *Archaea, Bacteria* and *Eukarya* as well as the JS1 candidate group, *Chloroflexi*, *Geobacteraceae, Crenarchaeota* and the functional genes *dsrA, mcrA, aprA*, and Rubisco (*cbbL*) have been quantified via qPCR. All genes have been detected in different copy numbers. The overall order of abundance is *Archaea* > *Bacteria* > *Eukarya*. Directly after IODP Expedition 331 in October 2010, culture media were inoculated with IODP samples at different temperatures and the enrichment cultures are maintained since then. Growth is continuously checked about every three months and in case of growth, colonies are picked and transferred to fresh media. Several aerobic and anaerobic enrichments have been obtained so far. To explore microbial activity in the original samples microcalorimetric measurements showed a considerable activity at 90°C which was partly attributed to microbial activity. The microcalorimetric measurements revealed activity of thermophilic microorganisms in the IODP Exp. 331 samples.

Sulfur and iron speciation in warm deep sediments affected by dry deposition of iron

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The Gulf of Aqaba is a unique natural laboratory for a research of the impact of atmospheric dry deposition on biogeochemistry of marine sediments. Atmospheric iron deposition is 3.65 mmol m^{-2} $year^{-1}$ [1], and total iron content of sediment at 700 m depth is 2.0 – 5.7 mmol kg^{-1} wet sediment. We sampled sediment at four locations with various overlaying water depths.

At water depths 300 – 700 m the depth of oxygen penetration into warm upper sediment (c.a. 21°C) is 8-14 mm. In anoxic sediments, combination of moderate TOC content (0.1-0.6%) with high sulfate concentration (32 mM) fuels organoclastic bacterial sulfate reduction. Concentrations of Fe(II) in the pore-waters are as high as 78 μM, and concentrations of dissolved Mn are as high as 76 μM. Combination of low hydrogen sulfide concentration in pore-waters (≤0.37 μM), low concentrations of soluble sulfide oxidation intermediates ($[S_2O_3^{2-}] \leq 0.55$ μM, $[SO_3^{2-}] \leq 0.14$ μM) and low sedimentary S^0 content (≤0.37 mmol kg^{-1} wet sediment) indicate that transformation of hydrogen sulfide to pyrite is fast enough to prevent sulfide oxidation by Fe(III) phases. Pyrite is the main sulfur pool in the sediment solid phase, and its content is up to 10.6 mmol kg^{-1}, with a maximum at 15 – 25 cm bsf.

At the shallow sediments (21 m water depths) penetration depth of oxygen is only 1 mm, and hydrogen sulfide concentration in pore-waters is as high as 12 μM. Dissolved iron and manganese concentrations below 5 cm bsf are lower than in the deeper sediments <1 μM and <0.5 μM, respectively. Concentrations of sulfide oxidation intermediates in pore waters ($[S_2O_3^{2-}] < 4.05$ μM, $[SO_3^{2-}] < 3.64$ μM) as well as in the solid phase $[S^0] = 0.07$-1.37 μmol kg^{-1} wet sediment are higher than at deeper locations.

The sediment of the Gulf of Aqaba presents an interesting example of transition of pore-water composition with depth from sulfidic (H_2S-rich) to ferruginous (Fe(II)-rich).

[1] Chase *et al*. (2006) Global Biogeochem Cy **20**, GB3017.

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