Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 908

The Geomicrobiology of a Relict Sulphide Deposit: Extending the Boundaries of the Submarine Hydrothermal Ecosystem

Silke Severmann (s.severmann@soc.soton.ac.uk)[1], **R John Parkes** (j.parkes@bris.ac.uk)[2], **Barry A Cragg** (b.cragg@bristol.ac.uk)[2], **Jon Telling** (j.telling@bristol.ac.uk)[2], **Jo Rhodes** (far2@tutor.open.ac.uk)[2], **Rachel A Mills** (r.a.mills@soc.soton.ac.uk)[1] & **Martin R Palmer** (martin.palmer@ic.ac.uk)[1]

[1] School of Ocean and Earth Science, Southampton Oceanography Centre, European Way, Southampton, SO14 3ZH, UK
[2] Dept. Earth Sciences, University of Bristol, Bristol BS8 1RJ, UK

Chemosynthetic bacteria are the primary producers of the unique hydrothermal ecosystems that are fuelled by geothermal energy. Recent observations from newly developing hydrothermal vent sites in the Pacific have shown that large plumes of anaerobic, thermophilic bacteria occur shortly after the volcanic seafloor eruptions (Summit & Baross 1998). This strongly points towards a subsurface origin of the bacteria, and it has been hypothesised that extensive microbial communities exist in the sedimentary layers below high-temperature vent fields (Deming & Baross 1993). The most important electron donor for microbial reactions in hydrothermal systems is dissolved sulphide, which is oxidised as hot vent fluids mix with seawater. Once active venting has ceased, reduced minerals in hydrothermal deposits will potentially provide a continuous inorganic energy source for chemo-lithotrophic bacteria. This study investigates the existence of microbial communities in sulphidic sediments from the *Alvin* zone, a currently inactive vent site in the TAG hydrothermal field at 26 08'N on the Mid-Atlantic Ridge.

Detailed geochemical and microbiological analysis, including bacterial enumeration (total counts and Mn/Fe-reducing bacteria) and microbial activity measurements (Thymidine incorporation, acetate utilisation S-reduction/-oxidation activity) was performed on a 228 cm long sediment core from the southern periphery of the *Alvin* zone. The results of the geochemical analysis are presented elsewhere (Severmann *et al.*, this issue).

Total counts of viable cells and general activity measurements show that significant microbial communities continue to exist throughout the sediments even after active venting has ceased. Although bacterial populations are relatively small, they are healthy and well adapted to this potentially toxic environment. Irrigation of hydrothermal precipitates with oxygenated seawater produces steep geochemical gradients, thus providing an inorganic energy source that can be exploited by the bacteria over long periods of time.

The presence of Mn- and Fe-reducing bacteria coincides with elevated porewater concentrations of Mn and Fe (Figure 1). This indicates direct involvement of bacteria in the cycling of these metals, although it has not been possible here to determine their relative contribution to overall re-mineralisation compared to inorganic reactions. The occurrence of Fe-reducers in the surface sedimentary layer and above the Mn-reducers at depth appears to contradict the classic model of redox-zonation as a function of relative energy yield for successive metabolic processes (Froelich *et al.* 1979). The most likely explanation is source-related and post-depositional segregation of Fe- and Mn-oxides into oxic and anoxic micro-habitats.

Microbial reduction and oxidation of S was observed throughout the core, indicating that micro-organism are particularly active in terms of S-cycling. For deep-sea sediments extremely high sulphate reduction rates (maximum rate = 67 nmol/cm^3/d) were measured in the iron-stained carbonate cap. This is surprising, since organic carbon levels in these sediments are very low at only ~0.2%. The concomitant peak of acetate utilisation (maximum rate = 50 pmol/cm^3/d) indicates that acetate serves as an electron donor for the sulphate-reducing bacteria. Comparison of these two rates, however, clearly shows that acetate utilisation is insufficient to support the observed rate of sulphate reduction. This strongly suggests the synthesis of alternative electron-donors by chemo-lithotrophic bacteria to support the observed high rates of heterotrophic activity in these sediments. The absence of reduced solid-phase or dissolved sulphur species at this depth may be explained by the consumption of H_2S from sulphate reduction by microbial S-oxidation, thereby providing an alternative energy source for sulphate reducing bacteria. This requires the close association of chemosynthetic sulphate reducers and sulphide oxidisers along geochemical gradients in the heterogenous carbonate cap. A similar consortium of bacteria has been proposed to exist in the walls of hydrothermal vent chimneys (McCollom & Shock 1997).

The evidently episodic nature of hydrothermalism in the TAG hydrothermal field (Lalou *et al.* 1995) suggests that high-temperature venting may become re-established in the *Alvin* zone. In this case well-adapted micro-organisms in the subsurface will play an important role in the rapid re-colonisation of the site. The existence of active microbial communities in metalliferous sediments may therefore provide a continuum of bacterial populations between high and low temperature hydrothermal systems, thus representing an important transitional stage in the hydrothermal ecosystem.

Journal of Conference Abstracts
Volume 5(2), 909

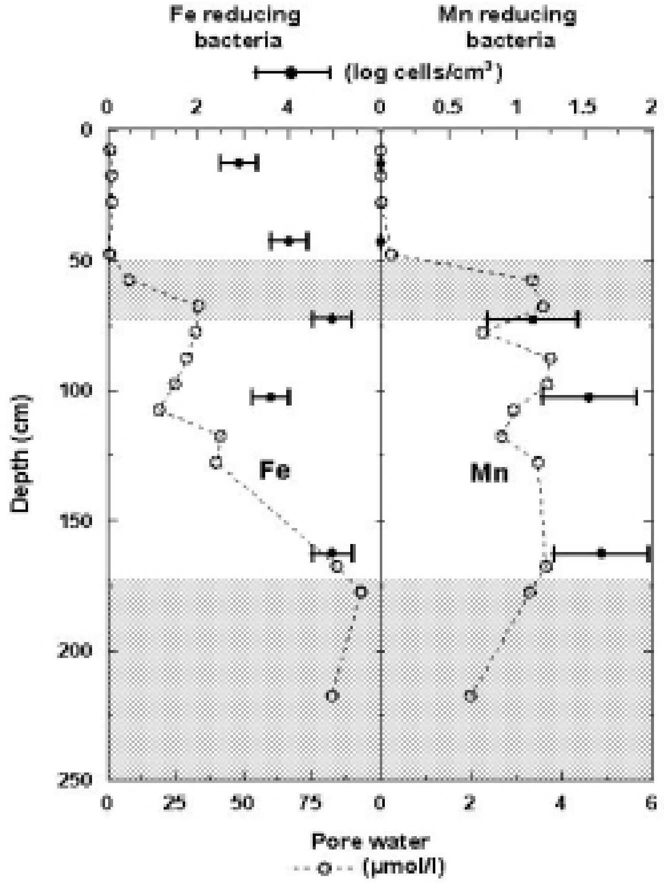

Figure 1: Porewater Fe and Mn concentrations and abundance of Fe- and Mn-reducing bacteria.

Deming JW & Baross JA, *Geochim. Cosmochim. Acta*, **57**, 3219-3230, (1993).
Froelich PN, Klinkhammer GP, *et al.*, *Geochim. Cosmochim. Acta*, **43**, 1075-1090, (1979).
Lalou C, Reyss JL, *et al*, *J. Geophys. Res*, **100**, 17,855-17,862, (1995).
McCollom TM & Shock EL, *Geochim. Cosmochim. Acta*, **61**, 4375-4391, (1997).
Severmann S, Mills RA & Palmer MR, *this issue*, (2000).
Summit M & Baross JA, *Dee-Sea Res.*, **45**, 2751-2766, (1998).