Identifying active vent deposit environments conducive for life

M.K. TIVEY[1]*, J.L. GRIBBIN[2], W. ZHU[2] AND A-L. REYSENBACH[3]

[1]Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA (*correspondence: mktivey@whoi.edu)
[2]University of Maryland, College Park, MD 20742, USA
[3]Portland State University, Portland, OR 97201, USA

Actively-forming vent deposits (chimneys and flanges) span temperatures from ~2°C to >400°C and provide microhabitats for a diversity of Bacteria and Archaea that are supported by the chemical disequilibria that result when reduced vent fluids mix with seawater within the porous and permeable walls of the deposit. Determining the actual thermal and chemical conditions *within* these deposits, however, is difficult. The deposits are dynamic, and heterogeneous mineralogically and texturally. These heterogeneities greatly affect transport of heat (by conduction ± advection), and mass (by diffusion and advection).

Insights into active chimney environments have come from field, laboratory, and theoretical experiments. Estimates of within-chimney environments (e.g. temperatures, pore fluid compositions) have been made using 1-D numerical models that consider heat and mass transport, with pore fluid pH calculated to be <3 up to 7 depending on vent fluid composition and extents of advection versus diffusion; comparison of observed and calculated mineral stability support these predictions [1].

Laboratory permeability measurements, however, made using a probe permeameter, document anisotropy in black smoker chimney walls. Permeability is lowest perpendicular to the inner chalcopyrite linings, higher in mid-layers, and highest in the outermost layers, suggesting more complex transport.

In situ temperature measurements, made as chimneys re-grow, encasing arrays of temperature probes placed over the orifices of razed chimneys, provide further data on conditions within chimney walls. Over time, walls thicken, become less permeable, and temperatures within the walls decrease. Periodic variations in temperature are also observed, with higher amplitudes in mid- and outer portions of walls.

We will present these data on *in situ* temperatures and permeability, their bearing on model calculations, and insights they provide into observed microbial diversity in active chimneys.

[1] Tivey (1995) *GCA* **59**, 1933–1949.

The potential of groundwater microbial communities to induce calcite precipitation

D.J. TOBLER* AND V.R. PHOENIX

Department of Geographical and Earth Sciences, University of Glasgow, Glasgow, G12 8QQ, UK (*correspondence: dominique.tobler@ges.gla.ac.uk)

Bacterially-induced calcite precipitation has been widely studied, mainly due to its importance in carbon cycling, but also due to its relevance for biotechnological applications such as wastewater treatment, removal of radionuclides and concrete crack remediation [1, 2]. Of interest to this study is the extent and kinetics of calcite precipitation in response to bacterial ureolysis. This process is assessed as a potential method to inhibit groundwater flow to seal porous zones and fractured rocks surrounding nuclear decommissioning and waste disposal sites. So far, most studies on ureolytic-driven calcite precipitation were done in artificial groundwater using the urease positive strain *Sporosarcina pasteurii*. Although this bacterium is a well-known model for soils, very few studies determined the potential of groundwater communities to hydrolyse urea and hence initiate calcite precipitation.

Here we present for the first time, a direct comparison of the rates of ureolysis and calcite precipitation between *S. pasteurii* and natural groundwater communities. A series of both anaerobic and aerobic batch experiments were carried out at a range of Ca and urea concentrations and the influence of different nutrients on the rates of ureolysis and calcite precipitation was assessed. Initial results indicate that the ureolytic activity from these particular groundwater communities is practically zero, but once these communities are stimulated with nutrients, ureolysis rates increase and calcite precipitation is induced. However, these rates are significantly lower than those obtained from aerobic experiments with *S. pasteurii* and most probably too low to plug soils and fractured rocks. In a second step, aerobically grown *S. pasteurii* was added to anaerobic groundwaters to allow a direct comparison of rates between groundwater communities and the model bacterium. Initial data from these experiments indicate that even under anaerobic conditions, the ureolysis rates by *S. pasteurii* are still significantly higher than those produced by stimulated groundwater communities. This suggests that to place a quick and effective seal, groundwater systems may need to be supplemented with ureolytic positive bacteria like *S. pasteurii*.

[1] Bang *et al.* (2001) *Enzyme Microb. Tech.* **28**, 404–409.
[2] Mitchell & Ferris (2005) *GCA* **69**, 4199–4210.