Biogeochemical patterns and processes in buoyant, deep-sea hydrothermal plumes

KATHLEEN WENDT[1], KARTHIK ANANTHARAMAN[2], JOHN A. BREIER[3], GREGORY J. DICK[2], KATRINA J. EDWARDS[4], PETER R. GIRGUIS[5], JEFFRY V. SORENSEN[1], JASON SYLVAN[4] AND BRANDY M. TONER[1,*]

[1]University of Minnesota, St. Paul, MN, USA, (*corresponding: toner@umn.edu)
[2]University of Michigan, Ann Arbor, MI, USA
[3]Woods Hole Oceanographic Institution, Woods Hole, MA, USA
[4]University of Southern California, Los Angeles, CA, USA
[5]Harvard University, Cambridge, MA, USA

Along the global mid-ocean ridge, sub-seafloor hydrothermal circulation results in the exchange of heat and chemical species between seawater and the ocean crust. The resulting thermally and geochemically altered fluids are vented at the seafloor. The mixing of cold, oxic deep-ocean waters with hydrothermal fluids creates plumes with physically and chemically dynamic features. Hydrothermal plumes represent a globally distributed interface where marine hydrothermal circulation exerts its biogeochemical influence on elemental budgets of ocean basins.

The goal of the present study is to describe the microbiological niches created by physical and geochemical gradients in plumes. One of our central hypotheses is that microorganisms respond to and alter the geochemistry of hydrothermal plumes. To achieve this goal and test our hypothesis, a field study was undertaken at the Eastern Lau Spreading Center (ELSC). While multiple vent sites along the ELSC are included in the larger study, here we report on an integrated, biogeochemical investigation of a single buoyant plume within ABE vent field.

A series of replicate sample sets were collected by *in situ* filtration at 0.5m, 40m, 200m within a buoyant plume using the *ROV JASON*. Above plume background and near bottom background sample sets were also collected. Hydrothermal plume particles in sample replicates or splits have been queried for bulk geochemistry, particle-by-particle mineralogy, and microbial community composition. These three data streams are being evaluated individually to characterize the geochemical and microbiological changes throughout the plume with respect to above and below plume backgrounds. In addition, an iterative and integrated analysis is being used to compare: (1) calculated mineralogy to direct measurements; and (2) predicted energy yields from chemoautotrophy to observed microbial composition.

Biogeochemical cycling of iron, sulfur and carbon in the nutrient-rich meromictic acid pit lake Cueva de la Mora (Spain)

K. WENDT-POTTHOFF[1]*, M. KOSCHORRECK[1], M. DIEZ ERCILLA[2] AND J. SÁNCHEZ ESPAÑA[2]

[1]UFZ – Helmholtz Centre for Environmental Research, Department Lake Research, D-39114 Magdeburg, Germany (*correspondence: katrin.wendt-potthoff@ufz.de)
[2]Instituto Geológico y Minero de Espana (IGME), 28003 Madrid, Spain

Cueva de la Mora is a meromictic, nutrient-rich acid pit lake with pronounced vertical gradients of physicochemical parameters in the chemocline and monimolimnion [1]. We studied microbial activity, abundance and biomass, and biogeochemical cycling of iron, sulfur and carbon to find out if (1) the high nutrient content influenced alkalinity-producing microbial processes compared to other acid pit lakes, and (2) if sediments in the shallow, mixed and the deep, stagnant parts of the lake exhibited biogeochemical differences related to meromixis. We hypothesized that redox cycling was more intense in the mixed part and higher amounts of reduced components would accumulate in the stagnant part.

Several biogeochemical reaction rates were higher than in typical acid pit lakes and fell rather within the range of neutral or weakly acidic lakes, probably a consequence of nutrient levels. Anaerobic processes occurred mainly in the sediments, and methanogenesis was negligible for the carbon budget of the lake. Sediments from the mixed and stagnant parts of the lake differed markedly. Mixolimnetic sediments showed high iron and sulfate reduction rates, and they appeared to undergo substantial recycling, as supported by reactive Fe(II) and Fe(III) profiles, relation between sulphate reduction and accumulation of reduced sulphur, and viable counts of iron and sulphur reducing and oxidising bacteria. Monimolimnetic sediments exhibited lower anaerobic microbial activities, and surprisingly accumulated more Fe(II) than mixolimnetic sediments, but less carbon and reduced sulfur. This might be explained by a strong separation of the monimolimnetic water body, resulting in comparably less input of energy (light) and allochthonous matter. The effect of alkalinity-generating microbial processes is not sufficient to neutralize the lake within a few decades.

[1] Sánchez España J, López Pamo E, Diez M, Santofimia E (2009), *Mine Water Environ* **28**:15-29