Letters of Intent: EPR
Target Date: August 15, 2003

Sulfide oxidation in the shallow subsurface at hydrothermal vents: The role of filamentous sulfur producing microbes

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(This letter of intent was received too late to be considered for support by the Ridge 2000 program. However, the proposal will be submitted to NSF, for the August 15, 2003 target date and the PIs wish to integrate their efforts with those of other PIs working at the site towards the goals of the R2K ISS Implementation Plan.)

Description of planned research for a proposal to be submitted to the RIDGE 2000 Program (EPR Integrated Study Site) for the August 15, 2003 NSF target date:

Microbial oxidation of geothermally produced sulfur compounds through chemosynthetic processes, principally hydrogen sulfide, supports dense animal communities surrounding hydrothermal vents. However, very little is known about the microbial communities in the interior and subsurface portion of hydrothermal systems due to its limited accessibility. Several recently published observations of "microbial eruptions" point to the existence of a subseafloor biosphere that contributes considerably to the productivity of these hydrothermal systems: Extensive discharges from so-called "blizzard" or "snowblower" vents (e.g., 9°N and Endeavor ridge) released large amounts of white flocculent material which accumulated into mats of 5 cm thickness (Haymon et. al., 1993, Earth Planet. Sci. Letts. 119). This material was later identified to consist of elemental sulfur in a novel filamentous form. It was found to be identical to material formed by a new type of H2S-oxidizing bacterium, which is unique among Prokaryotes in that it excretes filamentous sulfur (0.5 µm wide, 20-500 µm long) as a product of its metabolism (Taylor & Wirsen, Science, 1997, 277). The process of microbial filamentous sulfur formation was recently documented to rapidly occur on new surfaces throughout 9°N EPR deep-sea hydrothermal vent system as well as in shipboard experiments using inocula collected from these sites (Taylor et. al., 1999, AEM, 65; Sievert & Taylor, 2002, unpubl.). All of this indicates that a shallow, non-thermophilic, subsurface biosphere dominated by filament-producing H2S oxidizers may be an important component heretofore unconsidered in the overall organic production at deep-sea hydrothermal vent sites.

The organism responsible for this process in the laboratory has been identified as an Arcobacter sp. belonging to the epsilon proteobacteria, and it seems perfectly adapted to this habitat. It is microaerophilic, tolerates high sulfide concentrations, is able to fix N2, and filamentous sulfur formation permits the organisms to exist in high fluid flow environments. An interesting aspect of this organism is, that it fixes CO2 by the reductive TCA cycle, which results in a distinctively heavier stable carbon isotopic composition of the formed biomass compared to the Calvin cycle. We propose that this may have important implications for primary production assessments and carbon isotope analyses conducted at hydrothermal vents. At present, our understanding of the microbial ecology of this process and its importance for the ecosystem is very limited.

We are planning to submit a proposal to study the abundance, distribution, and diversity of filamentous sulfur producing microbes and to assess their ecological role at 9¾N on the EPR. Because of previous observations and the high likelihood for observing accretionary events with output of subsurface biomass, this site is perfectly suited to address these questions. Samples at hydrothermal vents will be taken from various habitats including warm water discharges, hydrothermal surfaces, plumes, and if possible from the shallow subsurface (in the event of "snowblower" emissions) concurrent with the measurement of relevant physicochemical parameters (temperature, pH, sulfide, oxygen). In addition, we will deploy and recover devices that provide surfaces for quantifying in situ colonization by microbes at the vent sites, will implement a newly developed device for uncontaminated in situ microbial sampling and will set up shipboard enrichments for cultivation of colonized microbes. We will use molecular biological methods (16S rRNA, functional genes) to assess the microbial community composition and radiotracers to measure process rates, e.g., CO_2-fixation rates. At the same time, the microbial community composition will be analyzed by looking at signature lipid biomarkers, providing an independent assessment of the microbial diversity in this system. Specifically, we will analyze Archaeal and Bacterial intact glyco- and phospholipids that form cell membranes and serve as diagnostic markers for specific groups of microorganisms. Stable isotope ratios of both bulk organic carbon, and specific lipid biomarkers, as well as dissolved inorganic carbon will be used to reveal sources of organic matter used by microbes.

(We are aware of the proposal by Lutz et al., that is going to be funded. In our opinion the present proposal would ideally supplement their work in that our work would extend the investigations into the subsurface habitat .and specifically look at an important process. The proposed use of time-lapse camera deployments would be attractive to us. To date, there is exists no information on how frequent the “snowblower” eruptions are. We will contact this group to coordinate cruises and sampling).

NOTE: This letter of intent was received too late for consideration by R2k but will be submitted to Core.