Letter of Intent: Biological and environmental factors controlling Archaeal species distribution along the Endeavour Segment

PI: Juliann Waits, Dept. of Biology, University of Memphis
Co-PI: Jennifer Houghton, Dept. of Earth Sciences, University of Memphis

This study proposes to integrate the wealth of geochemical and microbiological data from mid-ocean ridge hydrothermal vents, specifically focusing on fluid chemistry and microbial movement, to evaluate species diversity (including richness and equitability) and physical characteristics of motility that drive microbial community assemblages. This interdisciplinary research will be multi-faceted, combining an in situ evaluation of microbial movement and presence within/between plumes and chimneys over distance with an experimental culture-based investigation of the influence of hydrothermal fluid chemistry on movement of key lithoautotrophic Archaeal species. *We will test the following primary hypothesis: Archaeal distribution is determined by fluid chemistry and availability of nutrients drives the movement of microorganisms; thereby flagellated individuals have an advantage over sessile microorganisms in hostile environments, during rapid chemical change, and chimney colonization events.*

Phase I is a compilation and evaluation of the extensive hydrothermal literature to provide an integrated database of mid-ocean ridge hydrothermal geochemistry and microbial diversity for detailed statistical analysis. A global integrated survey to determine the links between geochemical habitats and microbial species presence may distinguish novel characteristics of those microbes and their community structure. This phase is currently being conducted at the University of Memphis which houses Centers of Excellence in Bioinformatics, Genome Research, and STEM Microscopy. The proposed project is the first attempt to develop a database on hydrothermal vent characteristics and biological species presence for use in predictive microbe and microbial community modeling.

Phase II will be a culture-based study to investigate the ability of Archaeal strains, such as flagellated species - *Pyrococcus* and *Archaeoglobus*, to track and selectively move within a flowing chemical gradient were pockets of nutrients are separated spatially. Experiments will be performed in the biogeochemical and environmental genetics labs at the University of Memphis. Ultimately, we will investigate the dynamics of interactions between these potentially syntrophic Archaea within controlled thermal and chemical gradients under hydrothermal conditions. Results from the experimental examination of community dynamics will further constrain the interpretations of the colonization potential of microbes as illustrated in the predictive microbial community models generated from our database analysis in Phase I.

Phase III of this proposal will be a field based study involving collection of chimney, soft subsurface, and fluid samples from areas such as: diffuse flow, hydrothermal plum, near chimney, and at various distances between chimneys within the water column. If the combination of the predictive models of Phase I and the lab-based tests in Phase II hold, then we should be able to predict Archeal species presence at known sites (based on chemistry and temperature) throughout the sampling area.

With this proposal, we are initiating a long-term collaboration in hydrothermal geochemical experimentation (Dr. Houghton; Earth Sciences: Geology) and environmental, genetic, and physical characterization of extremophile microbes (Dr. Waits; Biology) necessary to successfully investigate global ecological questions in hydrothermal subsurface environments. The PIs have a vested interest in mentoring women in the sciences and will provide graduate and undergraduate students the opportunity to participate in this project.