Modeling Environmental Controls on Microbial Biogeography in Seafloor Hydrothermal Vent Systems

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Using a combination of geochemical modeling and statistical evaluation of an integrated dataset of hydrothermal fluid chemistry, chimney mineralogy, and microbial species presence at vent sites along mid-ocean ridges in the eastern Pacific, this study is designed to explain geochemical and microbial observations compiled from the literature within a framework consistent with ecological principles. Analysis of the accumulating integrated dataset seeks to 1. create a standardized comparison of data across time and space, 2. define microbial communities within and around each vent structure at the time of sampling, and 3. constrain the geochemical environment at each vent through time. However, given that microorganisms populate the interior of chimney walls at temperatures favorable for life (<150 degrees C), geochemical reaction path modeling can provide a more reasonable estimate of the chemical conditions within chimney walls than simply the end-member fluids sampled at the chimney orifice (>300 degrees C) commonly reported in the literature.

One chimney-scale modeling study nearing completion attempts to constrain the geochemical environment within concentric sections of a white smoker near Bio9 vent corresponding to a carefully subsectioned microbial survey study (Kormas et al., 2006) for which mineralogy was reported and fluid chemistry exists in the literature (Von Damm and Lilley, 2004). On a larger ridge scale, a second study is underway to statistically evaluate the currently compiled microbial survey data from 28 studies (using 1090 observed clones and/or strains) along the East Pacific Rise and Juan de Fuca Ridge to determine the taxonomic distinctness or functional diversity (based on genetic similarity within populations) at various locations through time. This analysis uses methods specifically designed for cases in which the data only consist of presence/absence information without abundance (i.e. cell counts or biomass), which is of particular importance in the seafloor environment where measuring abundance of cells attached to rock while simultaneously identifying those cells phylogenetically is extremely challenging. Results of taxonomic distinctness begin to indicate shifts in observed diversity over time and space as well as between different sampling methods (i.e. chimney samples vs. in situ devices placed over vent emissions). Geophysical techniques that can quantify subsurface microbial biomass would be an extremely powerful tool to further our understanding of biomass distribution, particularly if it could be coupled to techniques of microbial identification and geochemical function.

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4. No