

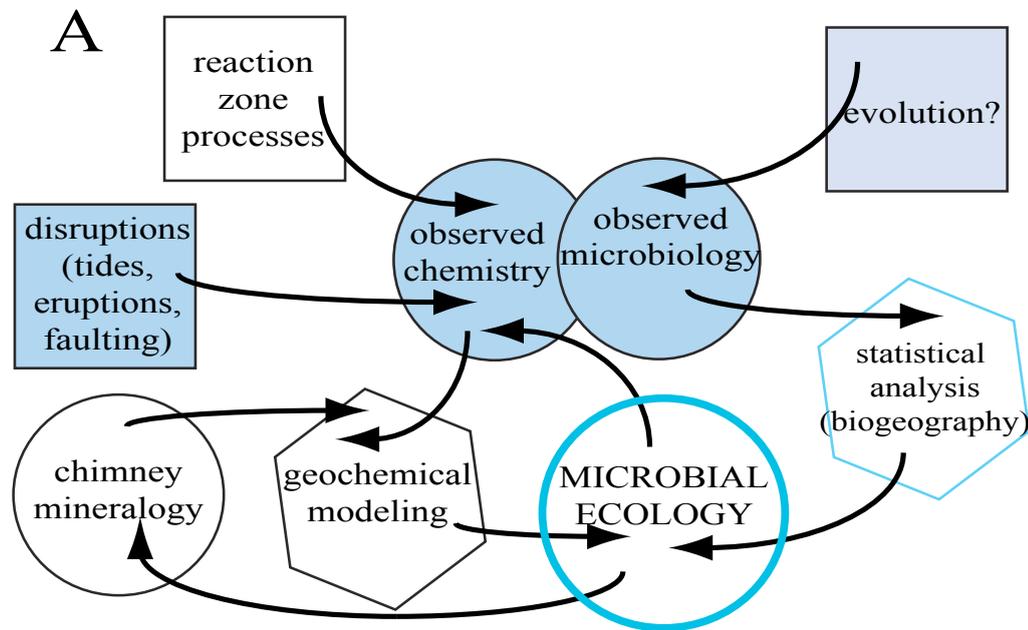
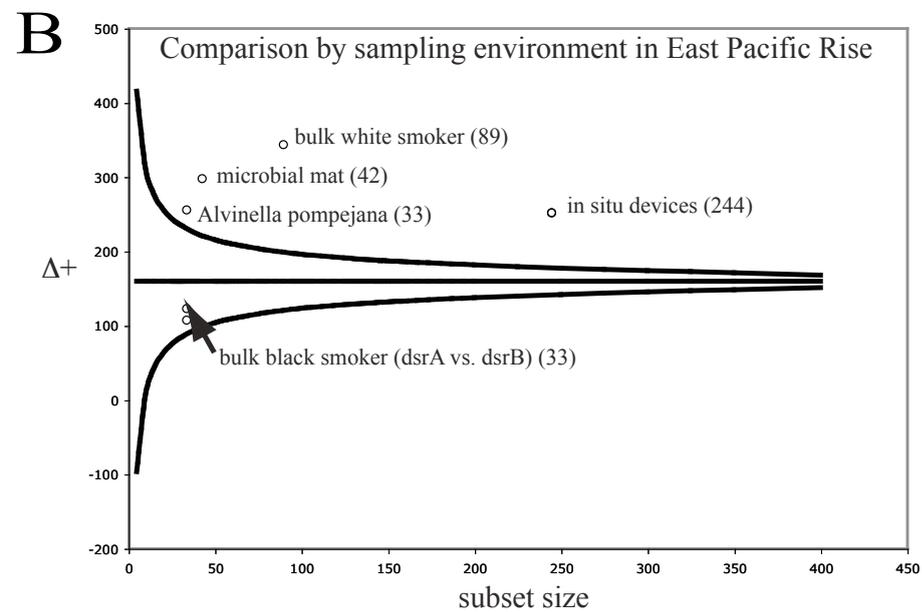
Evaluating Microbial Biogeography Through Integration of Existing Geochemical and Microbial Datasets

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Ongoing assembly of an integrated dataset compiled from the literature concerning vent fluid chemistry, chimney mineralogy, and microbial species presence at vent sites along the East Pacific Rise 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. Initial efforts to assemble a truly integrated biogeochemical database brought to light the problem of mismatching fluid chemistry and microbial survey datasets in time and space for all studies but the most recent (published 2006 and later), thus requiring a more indirect comparison of geochemical data with microbial data. Concerns have also been raised that the endmember vent fluid is likely not representative of the chemical micro-environment that single-celled organisms are exposed to within chimney environments. However, geochemical reaction path modeling that produces results consistent with observed chimney mineral paragenesis can provide a more reasonable estimate of the chemical conditions within chimney walls.

One such small-scale modeling study is nearing completion that will define the geochemical environment within concentric sections of a white smoker near Bio9 vent corresponding to a carefully subsectioned microbial survey for which mineralogy was reported and fluid chemistry exists in the literature. On a larger ridge scale, a second study is underway to statistically evaluate the currently compiled microbial survey data from 20 studies (using 483 observed clones and/or strains) along the East Pacific Rise to determine the taxonomic distinctness ($\Delta+$) or functional diversity (based on genetic similarity within populations) at various locations through time. This type of analysis was specifically designed for cases in which the data only consist of presence/absence information without abundance (i.e. cell counts or biomass) (Clarke and Warwick, 1998). Our approach involves a combination of geochemical modeling and statistical evaluation of the ever-expanding microbial dataset (Figure, part A) to explain geochemical and microbial observations within a framework consistent with ecological principles. Results of taxonomic distinctness ($\Delta+$) begin to indicate shifts in observed diversity over time and space (Figure, part C) as well as between different sampling environments (i.e. black smoker chimneys vs. white smoker chimneys) (Figure, part B).

The current statistical analysis indicates the majority of vents sampled exhibit lower than expected functional diversity compared to the full East Pacific Rise dataset, suggesting that unique populations exist in different environments defined either by location or sample type. Should this conclusion remain robust as a more comprehensive dataset is compiled, a detailed analysis of both modeled and observed geochemistry may determine the environmental controls on taxonomic distinctness (that is: are the same niches being filled by phylogenetically unique representatives at different vents, or are there unique niches at different locations?)



(A) Schematic of the interactions between environmental factors and microbial communities in hydrothermal systems. Blue shading represents components that experience change over time relevant to microbial processes.

(B) Statistical analysis of the current EPR database, grouped by sample type, showing the 95% confidence funnel. (Sample size is in brackets.) Microbial mats, bulk white smoker samples, in situ devices and epibiont communities of *A. pompejana* species have lower than average taxonomic diversity for the full EPR dataset.

C

(C) Map view of larger-scale ridge segments, color-coded for spreading rate (pink=slower, red=faster), with size of marker indicating $\Delta+$ value (larger size=less taxonomic distinctness). Map inset shows 95% confidence funnel with individual vent subsets plotted by sampling year. All vents except Elsa (13N EPR) exhibit lower than average distinctness.

