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Geomicrobiology in oceanography: Mineral-microbe interactions in the deep sea

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At mid ocean ridge (MOR) spreading centers and seamounts, the ocean crust is exposed to oxygenated seawater and microbes. On a global basis the MOR systems represents a ~600,000 km^2 continuous rock-colonizing ('epi- and endo-lithbiontic crusts') community of microbes, ranking it the largest rock-hosted microbial ecosystem on Earth. Fluid circulation at ridge flanks and seamounts may "inoculate" the subsurface, extending this ecosystem hundreds of meters into porous basement. In theory, microbes can propagate where water, nutrients, and energy are available, and temperatures permit. However, few studies have empirically examined the nature of deep-sea hock hosted microbial ecosystems in any detail. Consequently, fundamental questions remain to be addressed, such as, what is the abundance and activity of these deep-sea microbial communities? What 'types' of microbes – from a phylogenetic and physiological standpoint – comprise deep-sea rock-hosted communities? And importantly, what role, if any, does this biosphere play in important geochemical processes such as rock weathering and elemental exchange between ocean and crust?

To answer these questions, we are studying deep-sea microbial communities at the Lo'ihi seamount, Hawaii, and at the East Pacific Rise 9°N (a RIDGE 2000 Integrated Study Site) on a long-term, time-series basis. A multi-disciplinary approach for studying microbial communities colonizing rocks and minerals at these sites will be discussed. Our work applies microbiological and geochemical methods for 'full-circle, spatially-resolved geomicrobiology': a suite of integrative, iterative approaches designed to link specific microbes and microbial communities with biogeochemical processes. The microbiological techniques involved include culturing, physiological studies, and both 16S rDNA and genomic sequencing to determine the composition and function of these communities. In-situ experiments with rock substrates, in tandem with examination and analysis of environmental samples, are being assessed using 16S rDNA phylogenetic approaches, fluorescence and electron microscopy, and synchrotron-based mineralogical and chemical methods. Our specific goals are to establish definitive roles for microbes in ocean crust weathering in the deep sea; however, in principal these types of approaches can be applied in an integrative fashion to study mineral-microbe interactions in a variety of Earth environments.