Microorganisms and the weathering of ocean crust at the seafloor

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A number of recent studies provide increasing evidence that oceanic lithosphere is capable of supporting a significant microbial community. Young basaltic crust is exposed on the seafloor along the global mid-ocean ridge system, where low-temperature fluid circulation is substantial. In these environments, oxidative weathering reactions of reduced compounds, such as FeO, in the basalt create a large change in free energy, which can be harnessed by microorganisms for metabolic growth. We are examining the microbial communities inhabiting seafloor ocean crust as well as performing mineralogical assessments of basalt alteration products to better understand the role of microorganisms in the early stages of seafloor weathering. These results will also allow us to more accurately assess the impact that microbially influenced weathering has on the cycling of metals and other redox-sensitive elements in the deep sea.

In the present study, we investigated the phylogenetic diversity and abundance of microorganisms living on and within seafloor ocean crust and the changes in these microbial communitites with increasing oxidative rock alteration. Basaltic lavas from the East Pacific Rise (EPR) at 9°N were collected for molecular biological and mineralogical analyses Phylogenetic analyses of the 16SrRNA gene was performed using clone libraries to examine species richness. Fluorescent in-situ hybridization and quantitative PCR were used to identify and quantify microbial colonization of the basalt surfaces. Mineralogical analyses were performed using electron microscopy.

Our study reveals that diverse, yet distinct populations of metabolically active bacteria inhabit young ocean crust, and these communities shift with changes in basalt alteration state. More specifically, an increase in species level diversity is observed with respect to an increase in weathering product accumulation (Fe- and Mn-oxides, clays, etc.). It is suggested that metal and sulfur-oxidizing autotrophic communities first colonize the fresh, unaltered rock substrate and provide the basis for more complex, heterotrophic communities, such as metal and S-reducers, as weathering persists. Additionally, these cryptoendolithic communities are more diverse and more abundant than communities in ambient bottom seawater, indicating that the microorganisms are likely deriving their energy from the weathering reactions.