Microbial weathering of seafloor hydrothermal sulfides

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The rates, pathways, and role(s) of microorganisms in the oxidative transformation of sulfide minerals have been studied in detail for over a century. However, though nearly all studies to date have focused on terrestrial environments, weathering of massive sulfides in well buffered, near neutral pH conditions at the seafloor likely plays a larger role in sulfide weathering on a global basis. We are conducting studies on hydrothermal sulfides in order to determine the role that microorganisms play in mediating the rates, pathways, and end products of weathering reactions. Recent studies conducted at the Juan de Fuca Ridge revealed that diverse metal-respiring bacteria are prominent members of sulfide weathering communities at low temperatures, and that Fe-oxidizing bacteria accelerate the dissolution of sulfide minerals. Current studies are examining a suite of extinct sulfides collected from a RIDGE2000 study site at EPR 9°N. A synthesis and comparison of these two sites will be presented, with focus on the role that Fe-oxidizing bacteria play in weathering.

One of the difficulties in assaying for the presence or absence of a specific microbial guild in the environment is determining an appropriate molecule or marker that can be used as a target. For example, several molecular targets are commonly used for sulfate reducing bacteria for the identification of functional (DSR) or phylogenetic (16S rDNA) genes. For Fe-oxidizing bacteria, however, no suitable markers currently exist. Fe-oxidation is broadly distributed among bacteria and archaea, and little is known about the genetics of Fe-oxidation. In order to determine an appropriate marker that may be applied in field samples we are taking a combined proteomic and genetic approach with the neutrophilic, facultative Fe-oxidizing bacterium *Marinobacter aquaeolei*. Using SDS-PAGE we have determined that a 36-kDa protein is induced in response to increasing Fe (II). Concurrent mutanogenic studies suggest that heme may be involved in Fe-oxidation for this organism. We will present these results and initial attempts to better characterize this protein.

Linking microbial and geochemical processes in geothermal habitats

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Geothermal environments are excellent model systems for understanding relationships among geochemistry and microbial processes. Geochemical attributes are important determinants controlling the selection and subsequent distribution of microorganisms in geothermal springs. Simultaneously, microbial activity plays an important role in dictating aqueous and solid phase chemical speciation within geothermal systems. Consequently, an understanding of both abiotic and biotic processes is necessary for fully appreciating factors that control geochemical and microbial speciation. We are particularly interested in elucidating mechanisms responsible for the biomineralization of S, Fe, As and Sb-rich solid phases within the outflow channels of geothermal springs in Yellowstone National Park (USA), and whether variation in spring geochemical composition can be correlated with consistent patterns of predominant microbial populations. Geochemical signatures of biomineralized phases may also serve as a geologic record of the aqueous geochemistry and microbial populations associated with different types of acidic environments. Our approach combines analyses of aqueous phase constituents including dissolved gases, a thorough evaluation of potential electron donors and acceptors using thermodynamic modeling and energetic analyses, determination of mineral composition and structure, molecular analyses (16S rDNA) to determine the distribution of microbial populations across microenvironments, and cultivation of microorganisms to confirm physiological traits and redox activities important in situ. Our work suggests that specific chemolithotrophic thermophilic populations are distributed as a function of geochemical properties and that their activities are directly responsible for geochemical processes important in the outflow channels of geothermal springs, including the precipitation and dissolution of secondary mineral phases.

References

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