

BIOENERGETICS OF HYPERALKALINE SPRING SYSTEMS OF THE SAMAIL OPHIOLITE AND THE POTENTIAL FOR A DIVERSE SUBSURFACE BIOSPHERE. P.A. Canovas^{1,2} and E.L. Shock^{1,2,3},¹GEOPIG, Arizona State University, ²School of Earth and Space Exploration, Arizona State University,³Department of Chemistry and Biochemistry, Arizona State University.

The ubiquitous nature of serpentinization and the unique fluids it generates have major consequences for habitat generation, abiotic organic synthesis, and biosynthesis. The production of hydrogen from the anaerobic hydrolysis of ultramafic minerals sets the redox state of serpentinizing fluids to be thermodynamically favorable for these processes. Consequently, a host of specialized microbial populations and metabolisms can be sustained. Active low-temperature serpentinizing systems, such as the Samail ophiolite in Oman, offer an ideal opportunity to investigate biogeochemical processes during the alteration of ultramafic minerals. At the Samail ophiolite in particular, serpentinization may provide the potential for an active subsurface microbial community shielded from potentially unfavorable surface conditions. Support for this assertion comes from geochemical data including Mg, Ca, CH₄ (aq), and H₂ (aq) abundances indicating that methane is a product of serpentinization. To further investigate viable metabolic strategies, affinity calculations were performed on both the surface waters and the hyperalkaline springs, which may be considered as messengers of processes occurring in the subsurface. Almost all sites yield positive affinities (i.e., are thermodynamically favorable) for a diverse suite of serpentinization metabolisms including methanogenesis, anammox, and carbon monoxide, nitrate, and sulfate reduction with hydrogen, as well as anaerobic methanotrophy coupled to nitrate, nitrite, and sulfate reduction. However, affinities for methanogenesis were not nearly as high as that of other reactions analyzed. This indicates that by the time the fluids have reached the surface, a deeper subsurface microbial population has already been working to exhaust the thermodynamic drive for methanogenesis. Reaction path modeling was performed to ascertain the extent to which serpentinization and mixing of surface waters with hyperalkaline spring waters in the subsurface can generate suitable habitats. The serpentinization model simulates the reaction of pristine Oman harzburgite with surface water to quantify the redox state and generation of hyperalkaline spring water. Preliminary results show that water-rock ratios as high as 100 could effectively reduce the system and create a thermodynamic drive sufficient to convert all of the dissolved inorganic carbon into methane. This indicates that the system is poised to create the reducing conditions necessary to support a subsurface biosphere very early in the ser-

pentinizing process, and that the subsurface biosphere could extend upwards to very near the surface. The mixing model simulates the percolation of surface water into the active serpentinization zone. During the mixing process, methane is calculated to be more stable than carbonate species until approximately 100g of surface water have been added to 1 kg of the serpentinizing fluid. These results suggest that unreacted surface water flowing directly into the serpentinizing zone can create the disequilibria necessary for methanogenesis, and possibly other metabolisms, to proceed while still maintaining the low redox state of the system. As long as the recharge to the hyperalkaline reservoir does not exceed ten percent of the reservoir, methanogenesis and other serpentinization metabolisms can thrive off the disequilibria generated through mixing.