Biological Potential in Serpentinizing Systems

Generation of the microbial substrate hydrogen during serpentinization, the aqueous alteration of ultramafic rocks, has focused interest on the potential of serpentinizing systems to support biological communities or even the origin of life. However the process also generates considerable alkalinity, a challenge to life, and both pH and hydrogen concentrations vary widely across natural systems as a result of different host rock and fluid composition and differing physical and hydrogeologic conditions. Biological potential is expected to vary in concert. We examined the impact of such variability on the bioenergetics of an example metabolism, methanogenesis, using a cell-scale reactive transport model to compare rates of metabolic energy generation as a function of physicochemical environment. Potential rates vary over more than 5 orders of magnitude, including bioenergetically non-viable conditions, across the range of naturally occurring conditions. In parallel, we assayed rates of hydrogen metabolism in wells associated with the actively serpentinizing Coast Range Ophiolite, which includes conditions more alkaline and considerably less reducing than is typical of serpentinizing systems. Hydrogen metabolism is observed at pH approaching 12 but, consistent with the model predictions, biological methanogenesis is not observed.

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