AN ENERGY BALANCE MODEL FOR THE HABITABILITY OF SERPENTINIZING SYSTEMS. T. M. Hoehler1, M. J. Alperin2, T. M. McCollom3, and K. L. Rogers4, 1Space Sciences and Astrobiology Division, NASA-Ames Research Center, 2Marine Sciences Department, University of North Carolina at Chapel Hill, 3Laboratory for Atmospheric and Space Physics, University of Colorado - Boulder, 4Department of Geology, University of Missouri - Columbia.

Introduction: Energy availability represents a key constraint on the size, distribution, and activities of many naturally occurring chemosynthetic populations. We have developed a conceptual model that casts habitability as a balance between provision of energy by an environment and biomass-normalized demand for energy by potential inhabitants, with both sides of the balance dependent on physicochemical environment. A quantitative application of this conceptual model has been developed to examine habitability in the specific case of methanogenic metabolism in serpentining systems. A spherical diffusion-reaction model is used to calculate rates of catabolic energy liberation at the single cell level, as a function of environmental temperature, pH, and concentrations of H2 and dissolved inorganic carbon. Comparison to estimates of cell-specific energy demands, which are likewise parameterized as a function of physicochemical environment, defines the habitable parameter space for methanogens in serpentining systems. The model is applied to two differing modes of cross-membrane transport: (a) cross-membrane transport of substrates and products is limited to diffusion of non-ionic species; and (b) “gated” or active transport of ions is allowed over a specified fraction of the membrane. Initial results suggest that mechanisms that enable cross-membrane transport of ions extends the range of habitable conditions into an area of parameter space representing highly serpentinized character (e.g., high pH, high H2), while the passive (diffusion-only) strategy may be most viable for systems exhibiting more neutral character.