Hydrogen Production and Habitability in Non-ultramafic Geologic Systems

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Dihydrogen (H_2) is a nearly ubiquitous product of water-rock interaction and is potentially an important reductant and source of energy for early life on Earth, for the rock-hosted deep biosphere, and for life beyond Earth. Previous studies on deep-sea hydrothermal vent systems suggest that H_2 produced by water-rock interaction feeds microbial ecosystems. However, such studies represent a small corner of physicochemical space where conditions are highly favorable for H_2 production. Lithogenic H_2 can be produced, however, across a range of rock types thus increasing the diversity of potential habitats on planetary bodies.

We present the results of field measurements and modelling assessing the potential importance of H_2-based metabolisms in geologic environments other than serpentizing systems. Aqueous H_2 concentrations were measured in spring waters across the western U.S. at sites including Yellowstone National Park, Lassen Volcanic National Park, Idaho Batholith, Oregon Cascades, and California's Long Valley Caldera. The springs at these sites are hosted in rocks ranging in composition from mixed alluvial sediments to rhyolite to andesite to basalt. Aqueous hydrogen concentrations reveal that dissolved hydrogen concentration can vary across several orders of magnitude irrespective of host rock type, and absolute values overlap those found in serpentinizing ultramafic sytems. Thus, H_2-based metabolisms may be supported in a range of geologic environments beyond ultramafic rocks.