The chemical utility of serpentinization products

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Serpentinization categorically describes the hydrolysis and transformation of primary ferromagnesian minerals such as olivine ($(Mg,Fe)_2SiO_4$) and pyroxenes ($(Mg,Fe)SiO_3$) to produce a wide variety of secondary minerals and H_2-rich, extremely reducing, high pH fluids over a wide range of environmental conditions. The production of H_2 and H_2-dependent CH_4 in serpentinization systems has received significant cross-disciplinary interest especially with regards to the abiotic synthesis of organic compounds, the origins and maintenance of life, and energy resources. Here the dynamics, utility and application of serpentinization products at high and low temperatures, specifically focusing on the fluids and gases produced, is presented. Serpentinization-related fluids and gases are evolved at relatively fast rates even in low temperature environments, stressing the importance of assessing temporally-dependent mineral formation, low crystallinity/amorphous precipitates and multiple chemical pathways. To one extent, the rates and dynamics of H_2 and CH_4 production and FTT synthesis may be coupled to put forth a model to assess whether life is present in an ultramafic hydrothermal system. One major caveat of H_2 production is that carbonate oversaturation has been shown to reduce H_2 production. As a supplemental pathway, fluids can be (further) driven to carbonate oversaturation related to the increase in pH as serpentinization proceeds. The rate of pH increase relative to carbonate saturation is especially relevant at lower temperatures. As H_2 and its inherently temporally-dependent pathways are interconnected, network and compartmentalization models provide a means to parsimoniously test the circumstances that are capable of producing H_2 and related CH_4 with an emphasis on how it may advance deciphering the prebiotic synthesis of organic compounds.