One-carbon (bio?)geochemistry in subsurface waters of the serpentinizing Coast Range Ophiolite

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Serpentinization – the aqueous alteration of ultramafic rocks – typically imparts a highly reducing and alkaline character to the reacting fluids. In turn, these can influence the speciation and potential for metabolism of one-carbon compounds in the system. We examined the aqueous geochemistry and assessed the biological potential of one-carbon compounds in the subsurface of the McLaughlin Natural Reserve (Coast Range Ophiolite, California, USA). Fluids from wells sunk at depths of 25-90 meters have pH values ranging from 9.7 to 11.5 and dissolved inorganic carbon (DIC concentrations) generally below 60 micromolar. Methane is present at concentrations up to 1.3 millimolar (approximately one-atmosphere saturation), and hydrogen concentrations are below 15 nanomolar, suggesting active consumption of H_2 and production of CH_4. However, methane production from CO2 is thermodynamically unfavorable under these conditions. Additionally, the speciation of DIC predominantly into carbonate at these high pH values creates a problem of carbon availability for any organisms that require CO2 (or bicarbonate) for catabolism or anabolism. A potential alternative is carbon monoxide, which is present in these waters at concentrations 2000-fold higher than equilibrium with atmospheric CO. CO is utilized in a variety of metabolisms, including methanogenesis, and bioavailability is not adversely affected by pH-dependent speciation (as for DIC). Methanogenesis from CO under in situ conditions is thermodynamically favorable and would satisfy biological energy requirements with respect to both Gibbs Energy yield and power.