Origin of dissolved C_1-C_4 hydrocarbons and assessment of methanogenesis in deep subsurface fracture water: Soudan, Minnesota

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Ancient fluids and anoxic gases expelled from crystalline rock aquifers can be used to investigate the habitability of the terrestrial subsurface [1, 2]. What is unknown is the extent to which microbes influence the geochemistry of these environments. We will present geochemical results from legacy boreholes drilled into 2.7 Ga banded iron formation at the 27th level of the Soudan Mine, MN. The mine floor is 713.5m below the surface, and borehole depths extend to > 100m. Saline water and gas flow from these boreholes at rates of 1.1-3.3 ml/s and 0.2-0.4 ml/s, respectively, with a pH range of 6.1-6.9 and a temperature of 11.8°C°. Methane abundances (57%-81%) are high when compared to those of C_{2+} hydrocarbons (1.6% C_2H_6, 0.34% C_3H_8, and 0.12% n-C_4H_{10}). The genesis of subsurface C_1-C_4 hydrocarbons could be attributed to either biogenic, thermogenic, or abiotic processes, or some combination of processes. Alkane C_1/C_{2+} ratios of 25 to 48 in preliminary results indicate that mixed sources of hydrocarbons are likely. Ongoing stable carbon and hydrogen isotope analyses will further constrain possible origins, and provide indirect evidence for or against possible methanogensis in the deep subsurface at Soudan Mine. In tandem with our analysis of C_1-C_4 alkanes, we are investigating the possible utilization of dissolved organic compounds as a substrate for methanogenesis via genomic assessments of microbial communities. We aim to determine the concentrations of dissolved organics in order to understand the sources and cycling of dissolved and volatile organics in the deep terrestrial environment.

[1] Sherwood Lollar et al. (2006) *Chem. Geol.*, **226**, 328-339
[2] Ward et al. (2004) *GCA*, **15**, 3239-3250