Origin of dissolved C$_1$-C$_4$ hydrocarbons and assessment of methanogenesis in deep subsurface fracture water: Soudan, Minnesota

W. DOWD$^{1*}$, C. SHEIK$^2$, B. TONER$^3$, C. SANTELLI$^4$, C.J. SCHULER$^3$, J.M. McDERMOTT$^1$

1Dept. of Earth and Environmental Sciences, Lehigh University, Bethlehem, PA United States 18015; *Correspondence: wsd218@lehigh.edu
2Dept. of Biology, University of Minnesota Duluth, Duluth, MN United States 55812
3Dept. of Soil, Water, and Climate, University of Minnesota Twin Cities, St. Paul, MN United States 55108
4Dept. of Earth Sciences, University of Minnesota Twin Cities, St. Paul, MN United States 55108

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$_2$H$_6$, 0.34% C$_3$H$_8$, and 0.12% n-C$_4$H$_{10}$). 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$_i$/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 methanogenesis 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.