Modern water-microbe-mineral feedbacks within a subsurface banded iron formation

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Subsurface microorganisms harbor a significant portion of the Earth's total living biomass that is decoupled from the rapid exchange processes occurring between the Earth surface and atmosphere. However, major knowledge gaps remain regarding the feedbacks among deep biosphere life, aqueous and volatile substrates, and host rocks, particularly in terrestrial environments.

Our multidisciplinary team is working in collaboration with the NSF Continental Scientific Drilling Coordination Office to investigate the strategies that microbial communities use to survive under difficult circumstances while living deep underground. Our field study centers on legacy boreholes and archived cores at Soudan Underground Mine State Park, an inactive iron mine that lies within the Neoarchean 2.7 Ga Vermilion Greenstone Belt of the Canadian Shield. These legacy boreholes act as positive-pressure, low flow (200 mL/min) access points to the hydrogeologically isolated, anoxic, saline, fractured-rock aquifer below, with total depths in excess of 800 m below ground surface

We seek to discover the mechanisms by which microorganisms inhabiting the brines interact with physical and geochemical components of the deep subsurface. We are specifically interested in understanding the feedbacks that microbial metabolism has on the habitability of fractured-rock aquifer systems, and how coupling among physical, chemical, and biological components determines the energy and substrates available to sustain a biosphere throughout time. Microbial waste products may create new space for growth, and new neighborhoods for microbial life, or may condemn inhabitants to inevitable death. This presentation will describe our hypothesis-driven approach and highlight emerging results from our collaborative team representing the disciplines of geology, hydrogeology, geochemistry, and microbiology.