Elemental sulfur biomineralization and preservation in glacial sulfide springs

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Microbial activity can control the abundance and distribution of sulfur species in environments far from chemical equilibrium, including the precipitation of intracellular and extracellular elemental sulfur in association with organic structures such as surface coatings, cell surfaces, filaments and sheaths. However, the potential for the generation and preservation of S0 mineral deposits that could serve as biosignatures of microbial sulfur cycling has not been extensively investigated. We will present a combination of synchrotron based x-ray spectroscopic, Raman, and pyrosequencing-based 16S rRNA and metagenomic data obtained from elemental sulfur deposits produced annually on the ice surface at Borup Fiord Pass in the Canadian High Arctic to define feedbacks between the geochemistry, microbial community composition, gene abundance, production of organic rich matrices and the chemical speciation of S0-rich deposits during their rapid precipitation and long-term preservation. This presentation will integrate findings from recently papers by Gleeson et al. [1], Wright et al. [2], Grasby et al. [3], as well as data from sulfur speciation mapping and x-ray absorption spectroscopy of modern sulfur deposits and “paleo” spring systems preserved in permafrost (Lau et al., unpublished).


Habitability and Hydrogen Generation in Peridotite Aquifers

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The habitability of peridotite aquifers depends upon the rate of generation of energy sources such as H2 and CH4 during low-temperature water-rock interactions, as well as the availability of oxidants and nutrients required for microbial growth. Recent work by Mayhew et al. [1] suggests that olivine and pyroxene can produce substantial H2 during water-rock interactions at ≤ 100°C through a surface-promoted mechanism where trace spinel phases such as magnetite, chromite and gahnite mediate electron transfer reactions between adsorbed Fe(II) and water. Mayhew et al. [1] also hypothesize microbial activity will be spatially localized to sites of H2 production adjacent to spinel surfaces.

We will present this conceptual model for H2-generation during low-temperature peridotite hydration, including synchrotron-based Fe K-edge multiple-energy µXRF and µXANES mapping of altered olivine, pyroxene and San Carlos peridotite before and after H2 generation. We will also demonstrate that Oman harzburgites, which contain abundant Cr-spinels, produce the highest concentrations of H2 measured in low-temperature water-rock reactions. Changes in the Fe-speciation associated with experimental H2 generation by Oman peridotite will be compared against µXRF and µXANES data for samples that have experienced hydration and carbonation at near-surface temperatures in the Oman ophiolite [2]. Altogether, we suggest that extensive hydrogen generation should proceed at temperatures as low as 30°C during modern water-rock interaction in Oman and other peridotite aquifers, giving rise to an enormous potential for subsurface microbial activity when oxidants such as CO2 are available to sustain microbial growth and methanogenesis.