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 S^0 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 feed-backs between the geochemistry, microbial community composition, gene abundance, production of organic rich matrices and the chemical speciation of S^0-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absorption spectroscopy of modern sulfur deposits and “paleo” spring systems preserved in permafrost (Lau *et al.*, unpublished).

Gleeson *et al.* (2012) *Astrobiology* **12**, 135-150. Wright *et al.* (2013) *Frontiers in Extreme Microbiology* **4**, doi: 10.3389. Grasby *et al.* (2012) *Astrobiology* **12,** 1-10.

Habitability and Hydrogen Generation in Perditotite Aquifers

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The habitability of peridotite aquifers depends upon the rate of generation of energy sources such as H_2 and CH_4 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 H_2 during water-rock interactions at ≤ 100ºC 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 H_2 production adjacent to spinel surfaces.

We will present this conceptual model for H_2-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 H_2 generation. We will also demonstrate that Oman harzburgites, which contain abundant Cr-spinels, produce the highest concentrations of H_2 measured in low-temperature water-rock reactions. Changes in the Fe-speciation associated with experimental H_2 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 30ºC 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 CO_2 are available to sustain microbial growth and methanogenesis.

[1] Mayhew et al. (in press) Nature Geoscience **6**. [2] Streit et al. (2012) Contributions to Mineralogy and Petrology **39**, 821-837.

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