The Geobiology that drives a sulfur-dominated glacial spring system found in the Canadian High Arctic.

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Introduction: The unique environment on the Galilean moon Europa makes it an ideal target for astrobiological investigation. This is evidenced by the presence of a subsurface liquid water ocean with a composition that can potentially support microbial life [1]. More specifically, the presence of hydrated sulfate salts and sulfuric acid on the icy surface supports the hypothesis that sulfur-based metabolisms could be fueled by water-rock interactions within the subsurface coupled with the delivery of oxidants via cycling of surface ice [1, 2]. Borup Fiord Pass (BFP) is a sulfur-dominated glacial spring system found on Ellesmere Island, Nunavut, Canada. BFP hosts one of the few cold-temperature sulfide springs that have been found in the Arctic [3, 4]. Along with being a candidate site to study low-temperature sulfur cycling, it has also been implicated as one of the best Earth-based analogs to study in preparation for a Europa lander [5].

Current Work: Research at BFP has revealed preliminary data about spring geochemistry, microbiology, biomineralization, and putative sulfur metabolisms [3, 6]. A 2014 field campaign to BFP was undertaken in order to collect a comprehensive set of samples, including those for microbiology, geochemistry, and minerology. During this campaign no active spring flow was observed, however the presence of past spring activity was observed via aufeis (spring-derived ice). BFP is visually striking as large accumulations of elemental sulfur on top of regional ices can be seen to cover an area of tens to thousands of square meters [3, 7]. These accumulations on top of the ice are accompanied by large proglacial icings formed when spring flow is frozen down-valley during winter months. These spring waters and aufeis are briny, sulfide-rich, and have been previously shown to host a diverse microbial community that may make use of sulfur metabolisms for growth [3, 4, 6].

Investigations into the microbial communities at BFP that utilize sulfur constituents for metabolic processes have revealed the dominance of organisms from the order Flavobacteriaceae as well as sulfur oxidizers from the Epsilonproteobacteria [4, 7]. Preliminary work examining 16S rRNA gene sequencing has shown the presence of these microorganisms from 2014 samples. Samples were separated by site type, including (but not limited to): melt pools, aufeis surface, and ice (Figure 1). Interestingly, on the Family level sites are similar, however on the Genus level microbial abundances are different, especially in the *Helicobacteraceae*. This leads us to believe that microbial processes may be different when comparing surface vs. near-subsurface communities. Comparisons with site geochemistry are being explored and may provide details on these differences between site type. Changes in community structure can also be seen in the same sample on different days. This may indicate (as does differences in sample types) that the sulfur-dominated site components are rapidly changing which is helping to drive community shifts in a short period of time. How this impacts overall sulfur cycling, is not yet clear. Ongoing interpretation of 16S rRNA gene sequences and geochemistry, as well as the addition of metagenomic data from these sites will help to strengthen our understanding of the microbial communities present and their impact on sulfur cycling at BFP. We hope this will help to further guide the search for potential astrobiological targets on Europa specifically at water/ice interfaces.

Figure 1 - Example of a melt pool site with researcher Alexis Templeton for scale.

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