

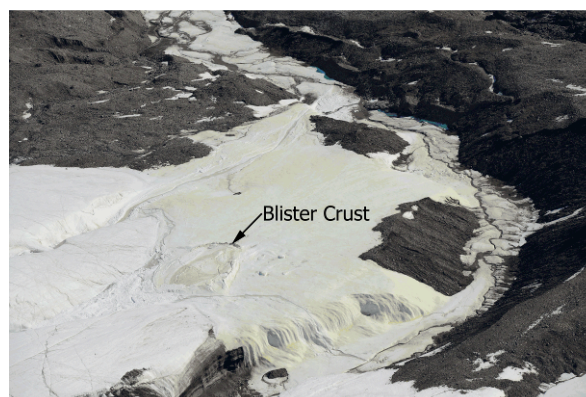
### Community Characterization of Microbial Populations found in Supraglacial Icings at Borup Fiord Pass.

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**Introduction:** The unique environment on the Galilean moon Europa makes it an ideal target for astrobiological investigation. In order to prepare ourselves for exploration of this icy moon it is important that we make use of Earth-based analogues. One such analogous habitat is the sulfur-dominated glacial spring system observed at Borup Fiord Pass in the Canadian High Arctic. In this system, subsurface microbial sulfate reduction produces H<sub>2</sub>S, which is transported through the glacier along spring channels [1]. As the surface oxidation of H<sub>2</sub>S occurs, resultant deposition of elemental sulfur (S<sup>0</sup>) becomes visible (Figure 1). The energy released from these reactions can support numerous microbial metabolisms even at the known limits of life (e.g. temperature, pressure, light, water, and energy availability), and may be a valuable representation of the processes occurring on Europa. The resulting sulfur minerals provide sensitive records of dynamic atmospheric, geological, hydrological, chemical, and biological processes on planetary surfaces. Building on this, we expect that the S<sup>0</sup>-rich deposits of this glacial spring system will serve as a mineralogical record for geochemical disequilibrium and biological activity. Decoding these preserved biosignatures will provide a valuable tool for recognizing potential sulfur-based life on Europa.

**Current Work:** During a recent collaborative expedition (2014) to Borup Fiord Pass in Nunavut, Canada, samples were taken from the toe of the glacier in an area called the ‘blister crust’ (Figure 1). At this location, glacial channels reach the surface, representing an active interface between subsurface and surface processes. Our research seeks to further characterize microbial communities found at this interface in order to elucidate information about how sulfur cycling occurs under these conditions. Results of a 2009 expedition revealed a variety of microbial community members, which were primarily dominated by the Epsilonproteobacteria *Sulfurovum* and *Sulfuricurvum*, both of which are known sulfur metabolizers. Further sequencing analysis of the spring water and sulfur deposits also revealed the presence of *Burkholderia*, *Ralstonia*, and *Flavobacterium* [2]. Wright et al. [2] hypothesize that the aerobic *Flavobacterium* depletes oxygen at the surface of the deposits and creates a microoxic environment below where *Sulfurovum* and *Sulfuricurvum* can flourish.

To expand on the results from 2009, and to further explore microbial physiology, the 2014 samples are being characterized with an integrated molecular and geochemical approach. Preliminary geochemical characterization of on-ice surface pools revealed 29 nM H<sub>2</sub> and initial estimates of up to 3.9 mM sulfide concentrations, almost as high as the 4.2 mM which was previously reported by Gleeson et al [3]. These concentrations likely serve the electron donation potential in this biogeochemical system. The mineralogy and sulfur speciation of the surface icings are being analyzed by FE-SEM/EDXS as well as synchrotron-based  $\mu$ XRF/ $\mu$ XANES. Furthermore, single cell and metagenomic techniques are being used to explore potential sulfur metabolism. Genes of interest include *sox* (ABCDXYZ), *sor* (AB), *sqr*, *apr*, *psr*, *ttr* (ABC) and *dsr* (ABCDEFGHIJKLMNPRS), as well as other metabolic, photosynthetic, and carbon fixation genes. Together these analyses will provide guidance into potential astrobiological targets on the surface of Europa, predominantly in regions where subsurface fluids interact with surface icings.



**Figure 1 – Picture of the spring site, showing S<sup>0</sup> deposition.**

**References:** [1] Grasby S. E. et al. (2003) *Astrobiology*, 3(3), 583-596. [2] Wright K. E. et al. (2013) *Frontiers in Microbiology*, 4(63), 1-20. [3] Gleeson D. F. et al. (2011) *Geobiology*, 9(4), 360-375.