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Lewis & Clark Fund in Exploration and Field Research Astrobiology

Biomarkers for Sulfur Metabolism in Icy Non-terrestrial Environments

PROJECT REPORT

The overall objective of the project was to study microbial sulfur metabolism at an arctic analogue site for non-terrestrial sulfur-rich, icy environments, in order to learn more about the potential habitability of such non-terrestrial environments, and the biomarkers that could potentially exist there if there is, in fact, any life present. The field site that was used was Borup Fiord Pass Glacier, Ellesmere Island, in the Canadian High Arctic (GPS coordinates 81°N, 81°E). This is a site that is uniquely suited to studying sulfur-metabolism in icy environments because there are extensive deposits of elemental sulfur and sulfate on the surface of the glacier, which surround a coldwater spring which rises through the glacier and which has very high levels of sulfide (Figures 1 and 2 below). The spring is not volcanic or from a thermal source, which makes it very different from sulfur hot springs that have been studied in places such as Yellowstone and Iceland. It is not known whether the elemental sulfur is of biological or non-biological origin, or a mixture of both. The direct association of sulfur compounds on the surface of the ice at Borup Fiord Pass Glacier makes it an excellent analogue for Europa, as the icy surface of Europa also has sulfur compound deposits on it. The glacier is also a good analogue for icy, sulfur-rich sites on Mars, or other planetary bodies.

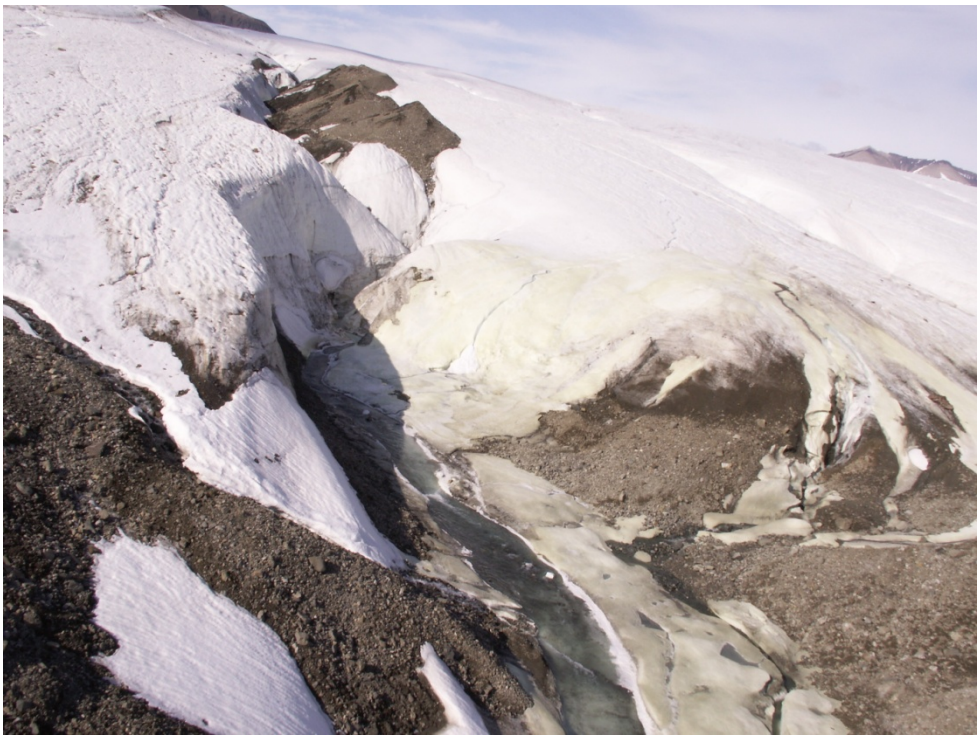

Figure 1: Borup Fiord Pass Glacier, Canadian High Arctic, July 2009

Figure 2: Close-up of elemental sulfur deposits on the surface of Borup Fiord Pass Glacier, Canadian High Arctic, July 2009

The Grant from the Lewis & Clark Fund in Astrobiology was used to help fund project fieldwork that took place in July 2009. During the fieldwork: measurements were taken in situ of pH and temperature; electrochemical analysis of the spring water was performed in situ, and samples of the spring water and surface sulfur deposits were taken for later analysis back at the laboratory. These analyses included geochemical analysis, and the extraction and sequencing of DNA.

The research demonstrated that this site is dominated by a community of microbes that use the oxidation of reduced sulfur compounds to obtain energy for primary productivity (the fixation of carbon). The expected overall impact of microbial activity would therefore be the oxidation of sulfide, elemental sulfur and other sulfur compounds, but cycling of different sulfur compounds is also possible. It was not possible to determine exactly which oxidation processes were taking place at the site and further research (beyond the scope of this project) would be needed to investigate that. The research findings have been published in:

Wright KE, Williamson C, Grasby SE, Spear JR and Templeton AS (2013) Metagenomic evidence for sulfur lithotrophy by Epsilonproteobacteria as the major energy source for primary productivity in a sub-aerial arctic glacial deposit, Borup Fiord Pass. *Front. Microbiol.* 4:63. doi: 10.3389/fmicb.2013.00063

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