Project Title: A Multidisciplinary Investigation of Salt Diapirs on Axel Heiberg Island, Nunavut

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Location: Axel Heiberg Island (Camp 1: 79° 4.285'N 090°, 12.755'W; Camp 2: 79° 25.900'N 094° 5.880'W) 420 km from Grise Fiord, the nearest community.

Time Frame: July 5, 2017, to July 18, 2017.

Number of people involved: 4

Project Description:
We propose a multidisciplinary investigation of salt diapirs on Axel Heiberg Island, Nunavut. Axel Heiberg Island is situated within the Sverdrup Basin, Nunavut, which is an intercratonic sedimentary trough containing at least 13 km of folded and faulted sedimentary rocks of the Innuitian Tectonic Province. At least 50 diapirs have been reported on Axel Heiberg Island. An understanding of the emplacement and evolution of salt diapirs is important for several reasons. First, salt diapirs elsewhere in the world represent prime traps for oil and gas and are also associated with lead and zinc mineral deposits – and there is the potential for such deposits on Axel Heiberg Island. Second, several of the salt diapirs on Axel Heiberg Island are host to perennial springs - the highest latitude such perennial springs on Earth. The Lost Hammer spring is the only documented methane seep in a cryoenvironment on Earth. Such springs offer important analogues for understanding how life may have evolved on Mars.

Transportation to the site will be by Twin Otter to a landing strip and then helicopter top the two camps. While on site, access to scientific sites will be by walking. Propane will be used for cooking. Unleaded fuel in jerrycans to refuel a generator will be stored at a secure distance from our tents on spill-kit sheets.

This island is uninhabited. The study site is located far from protected areas and parks but nevertheless, wildlife may be present, such as polar bears, caribou, foxes or migratory birds. If found or sighted, nests, dens or animals of any type will not be disturbed nor interacted with. No archeological sites are known to be located in the area – if we find a site, the location will be recorded and communicated to proper authority for further investigation. Helicopter flights will be at altitude to prevent animal disturbance.

A temporary camp will be erected consisting of a Longhouse-style tent (common living quarters) and four personal tents. Water for camp use (approx. 0.05 m^3 per day) will be collected from nearby streams. All combustible waste will be incinerated while all non-combustible waste will be returned to Polar Continental Shelf facilities for disposal.

At the conclusion of the field campaign, the camp will be dismantled and the terrain restored to its original state.

Methodology:
Objective 1) Remote Predictive Mapping
In advance of fieldwork, we are generating a remote predictive map using Radarsat-2, Landsat 8, ASTER, and other remote sensing data. In the field, we will measure surface profiles and volumetric soil moisture from several different geological units using a differential GPS, a lidar, and a portable dielectric probe. We will compare the measured surface roughness and volumetric soil moisture with the estimated values from the applied scattering models. The variation in surface parameters will be investigated with how it can affect on scattering mechanisms and polarimetric SAR signatures. Mapping and rock sampling will be carried out in order to ground-truth the remote sensing observations.

Objective 2) Biosignatures in Springs

This goal seeks to understand how biosignatures of microbial communities are preserved a consequence of “cryomineralisation” – i.e., mineralization in cold perennial springs. For all sampling sites, major environmental geochemical parameters will be measured in situ, including pH, temperature, redox potential, dissolved gases, and bicarbonate, with further fluid samples filtered, collected, and acidified for laboratory dissolved ion and dissolved organic carbon analysis.

Objective 3) Gullies

Gullies on Mars have morphologies similar to those carved by water on Earth, and have thus been of particular interest to the Mars science community since their discovery in 1999. However, their origin on Mars remains debated. We propose to collect the following data: 1) cross sections of individual gullies, which relates to substrate properties and gully activity level; 2) Long profiles of individual gullies, which can be used to distinguish between fluvial, debris flow, and dry flow systems; and 3) Measurements of substrate composition and grain size to tie them to morphological characteristics of the gully systems.