Complement for NPC application #149046

Project Title: Periglacial Geomorphology and ground ice investigation in the Haughton impact structure area, Devon Island, Nunavut

Project Overview: The objective of this project is to investigate the periglacial landscapes in and near the Haughton Impact Structure, within a comparative planetary framework. Glacier valleys, ground ice patterned ground, polygons and gullies will be studied using airborne and satellite images, sampled in the field and analyzed in a laboratory. Water (ice), when buried or underground, is an important paleo-indicator which could help clarify postglacial periglacial dynamics in arid and cold environments, either in the Arctic or on Mars.

This is a **project renewal** and continuation for 148506

Start and end dates: arriving July 17th, 2019 and leaving August 4th, 2019.

People on site: 6, during 19 days = 114 person-day

Project description:

This project aims to better understand paleo-glacial and periglacial processes as factors among many shaping the landscape in cold and arid regions. Such studies are critical for constraining past climates on Earth and Mars and how those evolved through time. The Haughton Impact Structure (Devon Island, NU) is a meteoritic impact crater, 23 km diameter in size and aged 39 Ma. The post-impact area in and near the crater is geologically heterogeneous due to the nature of the reworked rocks and landscapes, contrasting with the surrounding non-cratered area. This cold and arid landscape is uninhabited, literally absent of vegetation, which is ideal when studying which processes are important or not in shaping the landforms in the area. Ice wedges are present in specific geological and sediment formations. Many of those conditions such as cratered areas, a generally cold and arid climate mostly absent of vegetation, with gullies, ground ice and patterned ground make the study of the Haughton Impact Structure and neighborhood similar in many regards to Mars. Missions to Mars have yielded important results about the past and current distribution of water ice. However, there exists a fundamental gap in our knowledge about the distribution and amount of ice present in the shallow ground on Mars. The objectives of the proposed research are framed around understanding 3 processes that have been invoked for Mars, but for which there remain unresolved critical questions. [1] Glacial and periglacial environments with massive ice are readily identifiable using airborne or satellite imagery (thermokarsts, thaw slumps and disturbances): how was this ice buried and preserved in these landforms? Valleys with retreating glaciers on one end will be investigated along a time/deglaciation longitudinal profile. We will investigate and sample exposed glacier ice in moraines along the valley using a portable drill. Ground penetrating radar surveys will enable to map the ice-cored moraine for the buried ice. Ice samples will be extracted, thawed and stored in 30 ml bottles and in situ analyzed for temperature, pH and conductivity using a portable water tester. Water samples will be stored in a cooled container for preservation, filtered to

be later analyzed for ions, δ18O and δ2H, to build the local water fractionation curve and assess the ice age. [2] How different arrangements of patterned ground are forming in relatively uniform, flat terrain? Polygons are very common in the continuous permafrost zone characterizing the Canadian Arctic and on Mars. Yet, factors such as the climate, topography, the altitude and the geology of the deposits do not seem to consistently explain an alternation between low centre, high centre or a differing polygon geometry. Using available high-resolution satellite imagery, we will identify candidate sites with a high concentration of patterned ground of each type. Once in the field, we will investigate the nature of the deposits to understand in which type of ground the polygons formed. Then the target surface will be surveyed using a drone to build a numerical surface model. The third step is to perform and underground surveys over polygon cross-sections using a GPR and interpret the signal for massive ice. [3] What is the role of the periglacial processes in the evolution of gullies and fluvial channels on slopes? Several factors are involved in how gullies evolve: the presence of water recurrently flowing in the channels, the snow cover, the sun exposure, etc. Factors (ex: hydrology, evidence of recent activity, dry/wet flow) will be identified and mapped to feed a statistical model named Factor Analysis of Mixed Data, useful to correlate multiple quantitative and qualitative factors in the same analysis. Gully can afterward be classified function of what drives their erosion.

In addressing these objectives, we will develop an unprecedented and potentially profound understanding of the water ice reservoirs on Mars and how they have changed over time. This project will contribute to positioning Canada in a leadership position in the study of glacial and periglacial processes on Mars, and more broadly, as a leader in quantitative reconstructions of Mars' climate history.

Field logistics: We will reach the base camp using a Twin-Otter at 75.37 N, 89.53 W (decimal degrees) . Near the camp there is an appropriate landing strip. We will not have a helicopter at our disposal. We will use two of Kawasaki Bayou All-Terrain-Vehicle to visit sites of interest. We will have 10 x 20 L mogas Jerry-Cans, 1 L of engine oil to make the 2000 W portable generator and portable drill work. We have ample spillkit with us when operating engines. There is a dedicated secure emplacement in the camp to store fuel. We will be using water from the Haughton River for cleaning, cooking and drinking. Grey and used water will be sink in a pit dug in the permafrost, about 1 km from the river, to prevent possible contamination.

Location of the project to the nearest community(ies) (include distance(s) to communities):

Grise Fjord and Resolute Bay are the two nearest communities. Resolute bay is ~170 km west of our study site on Cornwallis. Grise Fjord is ~250 km NE on Ellesmere.

Location of the project to sensitive areas: There is no known sensitive areas near this site. The overall area is very dry, absent of vegetation, as it is quite desertic. Fauna (mammals, bird) are very rare.