The Canadian Arctic Archipelago: A Mars Glacial Analogue Site. A. Grau Galofre[1], G. R. Osinski[2], A. M. Jellinek[3], S. M. Chartrand[4] [1]School of Earth and Space Exploration, Arizona State University, Tempe, US (agraugal@asu.edu), [2]Department of Earth Sciences/Institute for Earth and Space Exploration, University of Western Ontario, London, Canada, [3]Department of Earth, Ocean, and Atmospheric Science, University of British Columbia, Vancouver, Canada, [4]School of Environmental Science, Simon Fraser University, Vancouver, Canada.

Introduction: Large-scale continental glaciation carved some of the most arresting erosional landscapes on Earth. The motion of large glacial ice masses sliding on their bed results in the scouring and quarrying of the landscape, exposing upon ice retreat landforms such as striae, moraines, drumlins, lineations, etc. (Fig. 1, left).

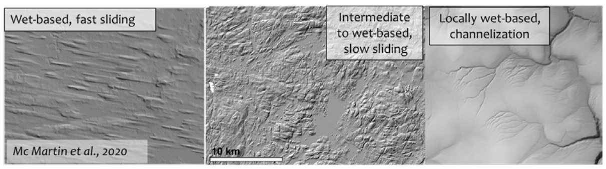

Figure 1: Landscapes eroded by wet-based (left), intermediate to wet-based (center) and locally wet-based (right) ice sheets (ArcticDEM, PGC, UMN). Note how the prevalent scouring patterns disappear from left to right as basal friction increases.

These features are largely absent on Mars, which has largely dissuaded researchers from considering that significant wet-based Martian glaciation occurred in the past. However, remains of the subglacial drainage system, such as sediment-filled conduits (eskers) found in the Dorsa Argentea Formation [1], the Argyre basin [2], and in localized areas of the northern lowlands [3], as well as possible subglacial channels among the Martian valley networks [4], provide evidence that water did exist under Martian ice masses.

The Arctic Archipelago as an analogue: The landscapes of the Canadian Arctic may help solve this conundrum: The thin Arctic ice caps mimic the driving stresses of Martian thicker ice masses, 'accounting' for the lower gravity. Ice thermal regime is largely cold based, with localized areas of basal melt that vary seasonally (polythermal). Polar desert climate has imprinted the glacial landforms with minimal fluvial modification since ice retreat [4, 5]. Our focus lies on Devon and Axel Heiberg Islands. Both islands currently contain relict ice caps with basal conditions ranging from cold to wet-based: the Devon ice cap and the Stacie and Müller ice caps (Axel Heiberg Island).

Devon Island: Our field site is located east of the Haughton impact structure, in central-north Devon Island [6,7]. Innuitian ice retreat revealed networks of subglacial channels oriented in the ice sheet paleoflow direction (S-SE to N-NW, Fig. 2). The striking morphological similarity of these subglacial channels to some Martian valleys, including planform shape, presence of longitudinal profile undulations, cross-section, and lack of inner channels, is suggestive that a fraction of Martian valley networks could have formed subglacially [4,8].

Axel Heiberg Island: Our field site is located SE from the Stacie ice cap margin. The terrain consists on flat plateaus dissected by glacial valleys, with groups of subglacial channel networks [8] incising the upper flat areas (Fig. 2). Whereas on Devon Island there was no evidence for glacial sliding, Axel Heiberg shows abundant glacial sliding signs (Fig.2) concentrated along the rugged western coast, where driving stresses are higher and rainfall is more abundant.

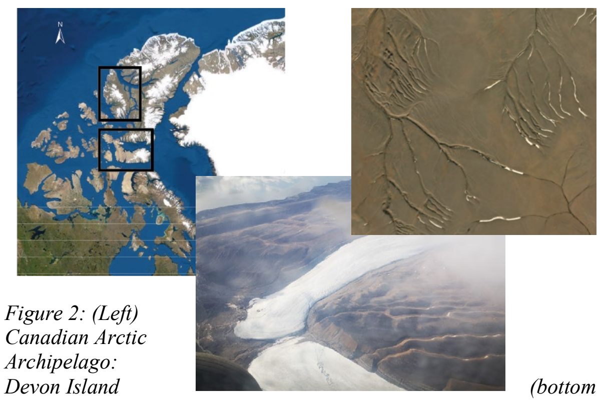
Figure 2: (Left) Canadian Arctic Archipelago: Devon Island (bottom box) and Axel Heiberg Island (top). (Right) Fingerprints of the channelized subglacial drainage system in Devon Island (right, credit: Maxar/Esri) and Axel Heiberg Island (bottom). Note the lack of scouring patterns when channels are present.

Conclusions: The landscapes of Devon Island and Axel Heiberg Island record uncommon wet-based glacial fingerprints: networks of bedrock-incised subglacial channels in flat plateaus, sliding glaciers in steep areas. These analogues capture the dynamic conditions of glacial motion on Mars, and thus provide valuable insight on Martian glaciation, suggesting that Martian ice masses may have shaped the landscapes in a different manner to what most terrestrial ice sheets did during the last glacial maximum.

References: [1] Head J. W. and Pratt S. (2001) *JGR: Planets*, *106*(E6). [2] Banks M. E. et al. (2009) *JGR: Planets*, *114*(E9). [3] Butcher, F.E.G. et al. (2017) *JGR: planets 122*(12), 2445-2468. [4] Grau Galofre et al., (2020). *Nature Geoscience,* [5] Dyke, A. (1999). *Quaternary Science Reviews*, *18*(3), 393-420. [6] Osinski G. et al. (2006) *Geoscience Canada*, *33*(4). [7] Grau Galofre, A. et al. (2018), *The Cryosphere, 12*(4), 1461 [8] Grau Galofre A., et al. *(submitted).*