2019 Nunavut Research Licence Renewal Application: Wayne Pollard

Project Title: An investigation of the sensitivity of high Arctic permafrost to climate change

Principal investigator: Dr. Wayne Pollard, Professor, Department of Geography, McGill University, 805 Sherbrooke St. W. Montreal, Quebec. H3A 0B9

2019 Research Team: Wayne Pollard (PI), Chris Omelon, Dale Andersen, Denis Lacelle, Melissa Ward (Ph.D.), Frances Amyot (M.Sc.) and 4 undergraduate field assistant from McGill – This is a university-based research project.

2019 Fieldwork Schedule: Planned fieldwork April 1- August 30.

2019 Field sites: The Eureka area on the Fosheim Peninsula, Ellesmere Island (80º00'N 85º95'W), and Expedition Fiord area, Axel Heiberg Island (79º25'N; 90º45'W). We will be based at the Eureka Weather Station and the McGill station on Axel Heiberg Island.

Funding source: Discovery Grant from the Natural Science and Engineering Research Council (NSERC). Logistical support is provided by the Polar Continental Shelf Program

Project Overview:
I am in the process of winding down a long-term project that examines how global warming, in particular warmer summer temperatures, is effecting the stability of high Arctic polar desert permafrost conditions, landscapes and infrastructure. This timeline corresponds with my NSERC funding awarded for this research. My long-term project aims include: (1) to identify and measure changes (and rates of change) occurring in tundra and polar desert landscapes related to increased active layer thickness and thermokarst, (2) to determine ground ice and permafrost characteristics and assess their vulnerability to climate change, and (3) to assess local climate variability. A secondary aim is to evaluate the effectiveness of shallow geophysical techniques, dGPS and UAVs to detect and monitor changing permafrost conditions. The importance of this research is highlighted by the dramatic increase in thawing permafrost observed in the extremely warm summers in 2011 and 2012. The information collected in this study will improve our understanding of how climate and permafrost interact, and the potential resiliency of the permafrost systems to unusual summer conditions, both of which will allow for the better prediction of future changes. This research also has a significant training component involving students on several levels.

Progress Report – 2018 Scientific Research Licence #02 023 18R-M (multiyear)
In 2018 fieldwork continued in the Eureka Sound area on Ellesmere Island and Expedition Fiord area on Axel Heiberg Island. My research team was based at the Eureka weather station for most of July during which we repeated on going measurements of thaw slump retreat and ice wedge subsidence around the Environment Canada weather station, runway and DND base. Fieldwork at Expedition Fiord area of Axel Heiberg Island was limited to only a few days due to 2 weeks in late July involving several undergraduate students. At Eureka work included dGPS, GPR and vegetation surveys in areas where thermokarst and erosion appear to be increasing (PhD. Research of M. Ward). Ice and soil samples were collected for chemical, organic carbon and ice content analyses. Results to date are interesting, we found that Total Soil Carbon (TSC) contents in the active layer for most of the area are extremely variable and seem to increase with depth. TSC in wetlands is much higher (2-5%) as expected. Since wetlands cover less than 3 % of the land area they represent a small potential carbon source. In 2018 the trend in active layer development and thermokarst was consistent with cooler summer conditions (Ward PhD). The Eureka area contains extensive massive ground ice deposits (massive ground ice refers to thick (3-10m) layers of nearly pure ice) beneath 1-4 m of marine sediments. The presence of massive ice makes this area extremely vulnerable to thaw subsidence and erosion. My work in the Eureka Sound Lowlands over the past 2 decades has

identified a series of “hotspots” where ground ice represents a significant part of the near surface permafrost. Since 2011 we have mapped thaw and changing landscape conditions related to ground ice almost everywhere below 150m asl. In 2012 we reported an unprecedented level of thermokarst (250+ retrogressive thaw slumps) but in 2018 (like 2013) the pattern of thermokarst was marked by low levels of activity. MSc student C. Roy completed her research on ground ice chemistry and identified an interesting spatial pattern linked to elevation. The monitoring or retrogressive thaw slump retreat is part of the PhD research by M. Ward. In addition to field mapping areas of thermokarst Ward is using satellite imagery to map and monitor landscape scale changes. Other fieldwork included ground penetrating radar surveys of ice wedges and massive ice deposits, sampling of ground ice and aerial surveys.

2019 Field Program.
This project is entering its final stage winding up 2020. The aim of my 2019 field program is to complete investigations concerned with the nature and distribution of ice-rich permafrost and in particular its vulnerability and thermokarst processes. My 2019 field program will address focus on: (1) changes in the active layer depth and its impact on surface topography, (2) changes in ice wedge morphology and (3) analysis of the chemistry of massive ground ice and ice wedge ice. The latter collaborative work with D. Lacelle. The measurement of changes occurring in the active layer remains a key focus as well as identifying connections between the atmosphere, active layer and permafrost. Fieldwork is planned for the Expedition Fiord area on Axel Heiberg Island (79º25N; 90º43’W) and the Eureka area on Ellesmere Island (79º59’N; 85º49’W). Our study sites were selected in 2012 and are representative of the most common ecosystems in this part of the Arctic. These sites were chosen because of their accessibility, availability of baseline data, and existing research facilities. This research will assess the sensitivity of key permafrost systems to warming by defining how surface temperature fluctuations influence the depth of the active layer and changes at the active layer permafrost interface. In this study we hope to identify critical thresholds of non-recoverable change known as tipping points, and potential feedbacks (main focus of my NSERC grant). In 2019 I am asking 2 key questions: (1) does the active layer buffer the permafrost system? And, (2) do ice wedge polygons respond differently than other permafrost systems? Activities planned for 2019 include the measurement of changes in the ground surface using a high resolution gps system coupled with ground penetrating radar. These data will be included in a geographic information system and will be used to geo-reference satellite images, (b) monitoring active layer processes and the measurement of temperature and moisture changes in mid-summer. This will involve the collection of sediment and ice samples from the active layer and top of permafrost, and (c) continued aerial surveys of changes throughout the Fosheim Peninsula. A component unsuccessfully initiated in 2018 is the utilization of a UAV to map spatial patterns of small scale surface change as well as thermokarst. We have updated the firmware on our UAV which hopefully has solved our problem.

Significance:
This research is making a significant contribution to the understanding of permafrost and ground ice conditions in the high Arctic. It has contributed new insights into the origin and age of permafrost systems, rates of change and the potential vulnerability of ice cored landforms and ice wedge polygons. The magnitude of warming projected for the high Arctic will have significant effects on both the ecology and geomorphology of the region. This work is even more important given the increased level of mineral exploration interests in this area. I have attached a copy of a recent report concerned with the evolution of massive ice on the Fosheim Peninsula.

Wayne Pollard

2019 ᓄᓇᖏᑦ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐱᔪᓐᓇᐅᑎᖓᓂᒃ ᓄᐦᑖᕈᕆᐊᖅᓯᓂᖅ: ᕗᐊᐃᓐ ᐳᓚᕐᑦ

<u>ᐱᓕᕆᐊᒃᓴᐅᑦ ᑕᐃᔭᐅᓂᖓ: ᖃᐅᔾᓇᕐᒃᓂᖅ ᖃᓄᑎᒋ ᐃᒃᐱᖕᓂᕐᑎᒋᕙᒃᒪᖕᖏᑕ ᖁᑦᑎᒃᑐᒥ ᖁᐊᖑᓂᖓ ᓄᓇᐅᑦ ᓯᓚᒧᑦ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᔪᒧᑦ</u>

ᐊᖓᔪᖅᑳᖅ ᖃᐅᔨᓴᕐᑎᓄᑦ: ᑑᒃᑕᖅ ᕗᐊᐃᓐ ᐳᓚᕐᑦ Dr. Wayne Pollard, ᐃᓕᓴᐃᔨᒻᒪᕆᒃ, ᓄᓇᒥᐅᑕᓕᕆᓂᕐᒧᑦ, ᒪᒋᐅ ᐃᓕᓐᓂᐊᕐᕕᒃᔪᐊᖓᓂ, McGill University, 805 Sherbrooke St. W. Montreal, Quebec. H3A 0B9

2019 ᖃᐅᔨᓴᕐᑎᐅᔪᑦ: ᕗᐊᐃᓐ ᐳᓚᕐᑦ , (ᐊᖓᔪᖅᑳᖅ), ᑯᕆᔅ ᐊᒥᓚᓐ. ᑕᐃᐅᓪ ᐋᓐᑐᓴᓐ, ᑎᓂᔅ ᓚᓯᐅᓪ, ᒥᓕᓴ ᕗᐊᑦ (ᐃᓕᓐᓂᐊᕐᑎ), ᐳᕋᓐᓯᔅ ᐊᒥᐊᑦ (ᐃᓕᓐᓂᐊᕐᑎ) ᐊᒻᒪᓗ ᑎᓴᒪᐃᑦ ᐃᓕᓐᓂᐊᕐᑎᑦ ᐃᑲᔪᕐᑎᖏᑦ ᒪᒋᐅ ᐃᓕᓐᐊᕐᕖᒃᔪᐊᕐᒥᑦ– ᐃᓕᓐᓂᐊᕐᕖᒃᔪᐊᕐᒥᑦ ᖃᐅᔨᓴᕐᓂᐅᔪᖅ.

2019 ᖃᖓᒃᑰᖓᓂᖓ ᐊᕋᒍᒥ: ᐊᐃᕆᓘᑦ 1 – ᐋᒋᓯ 30

2019 ᐅᐸᒃᑕᐅᓂᐊᕐᑐᑦ ᖃᐅᔨᓴᕐᕖᑦ: ᐅᓕᑲ ᖃᓂᒋᔭᖓᓂ ᓄᓇᖓᓂ Fosheim Peninsula, ᕿᑭᕐᑕᒥ Ellesmere Island (80º00’N 85º95’W), ᐊᒻᒪᓗ ᑕᕆᐅᖓᑕ Expedition Fiord ᓄᓇᖓᓂ, ᕿᑭᕐᑕᒥ Axel Heiberg Island (79º25’N; 90º45’W). ᑕᖖᕐᓯᒪᖃᑦᑕᕐᓂᐊᕐᑐᒍᑦ ᐃᐅᓕᑲ ᓯᓚᓐᓂᐊᕐᕖᒃᒥ ᐊᒻᒪᓗ ᒪᒋᐅ ᐃᓂᒋᔭᖓᓂ ᕿᑭᕐᑕᒥ Axel Heiberg Island.

ᑮᓇᐅᔭᖅᑲᕐᑎᑦᑎᔪᑦ: ᓇᓂᓯᓂᕐᒧᑦ ᐃᑲᔫᑕᐅᔪᓂᑦ ᓄᓇᒥᐅᑕᓕᕆᓂᕐᒧᑦ ᑭᒃᓕᓯᓂᐊᕐᓂᕐᒧᑦ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᑲᑎᒪᔨᖏᓐᓂᑦ Natural Science and Engineering Research Council (NSERC). ᐊᐅᓪᓚᕐᑕᕈᑕᐅᔪᓄᑦ ᐃᑲᔪᕐᑐᑦ ᐳᓗ ᑳᓐᑎᓂᑦᑐ ᓯᐅᓪᕝ Polar Continental Shelf Program

ᐱᓕᕆᐊᒃᓴᐅᔪᖅ ᖃᓄᐃᓕᖓᓂᖓ:
ᑭᖑᓪᓕᕐᐸᓲᕐᐸᓪᓕᐊᓕᕐᑐᖓ ᐊᑯᓂᐅᔪᒧᑦ ᖃᐅᔨᓴᕐᓂᐅᓯᒪᔪᖅ ᑐᑭᓯᓇᓱᒃᑐᒍ ᓄᓇᕐᔪᐊᕐᒥ ᐅᕐᑯᖅᓯᕙᓪᓕᐊᓂᖓ, ᐱᓗᐊᕐᑐᒥᒃ ᐊᐅᔭᒃᑯᑦ, ᐃᒃᐱᒃᓇᐅᑎᕙᓪᓕᐊᒃᒪᖕᖐᑦ ᖁᑦᑎᒃᑐᒥ ᓄᓇᖓᓂᒃ ᖁᐊᖑᐃᓐᓇᕐᓂᖓᓄᑦ, ᓄᓇᖓᓄᑦ ᐱᖁᑎᓄᓪᓗ ᓴᓇᓯᒪᔪᓄᑦ. ᑖᓐᓇ ᖃᖓᒃᑰᖓᓂᖓ ᒪᓕᒃᓯᒪᓪᓗᓂ ᑐᓐᓂᕆᔭᐅᓯᒪᓂᑦᑎᓐᓄᑦ ᑮᓇᐅᔭᓂᒃ ᖃᐅᔨᓴᕐᑕᑦᑎᓐᓄᑦ. ᐊᑯᓂᐅᔪᒧᑦ ᖃᐅᔨᓴᕐᓂᖅ ᑐᕋᖓᖃᕐᑐᖅ ᐅᑯᓂᖓ: (1) ᓇᓗᓇᐃᕐᓗᒋᑦ ᐆᕐᑐᕐᓗᒋᓪᓗ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᐅᔪᑦ (ᖃᓄᑎᒋ ᓱᒃᑲᑎᒋᖓᒪᖕᖏᑕ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᖏᑦ) ᓇᑎᕐᓇᒥ ᐊᒻᒪᓗ ᐱᕈᕐᑐᖅᑲᖏᑦᑐᒥ ᓄᓇᐅᑦ ᖄᖓᓃᑦᑐᑦ ᐃᔾᔪᑎᒋᓂᖓᓂᑦ ᐊᒻᒪᓗ ᐊᐅᒃᐸᓪᓕᐊᑎᒋᓂᖓᓂᑦ, (2) ᑐᑭᓯᓇᕐᒃᑐᒍ ᒪᓂᕋᕐᒦᑦᑐᖅ ᓄᓇᐅᓪᓗ ᖁᐊᖑᓂᖓ ᖃᓄᐃᑦᑑᓂᖒᓐᓂᒃ ᖃᓄᓪᓗ ᐃᒃᐱᒃᓂᕋᔭᕐᒪᖕᖏᑕ ᓯᓚᐅᑦ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᖓᓄᑦ, ᐊᒻᒪᓗ (3) ᖃᐅᔨᓴᕐᓗᒍ ᓯᓚᖓ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᖕᒪᖕᖏᑦ. ᐱᖃᑕ ᑐᕌᖓᐅᔪᖅ ᑐᑭᓯᓇᕐᒃᑐᒍ ᐃᓗᑐᔪᒥ ᓄᓇᖓᓂ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᖓ, ᖃᐅᔨᓴᕈᑎᓄᑦ dGPS ᐊᒻᒪᓗ UAVs ᖃᐅᔨᒋᐊᕈᑕᐅᓗᑎᒃ ᐊᒻᒪᓗ ᖃᐅᔾᓇᕐᒃᑐᒍ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᑎᒋᓂᖓ ᖁᐊᖑᓂᖓᑕ ᓄᓇᐅᑦ. ᐱᓪᓚᕆᐅᓂᖓ ᖃᐅᔨᓴᕐᓂᐅᔫᑦ ᖃᐅᔨᒪᔭᐅᓕᓚᐅᕐᒪᑦ ᐊᐅᒃᐸᓪᓕᐊᓂᖓ ᓱᒃᑲᓂᖅᓴᐅᓂᖓᓂᒃ ᐅᕐᑯᓯᑎᓪᓗᒍ ᐊᐅᔭᖓᓂ 2011 ᐊᒻᒪᓗ 2012. ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᑎᑎᕋᕐᑕᐅᔪᑦ ᑐᑭᓯᔭᐅᕙᓪᓕᕈᑎᒋᓂᐊᕐᒪᑕ ᖃᓄᕐ ᓯᓚᐅᑦ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᖓ ᓄᓇᐅᓪᓗ ᖁᐊᖑᓂᖓᓂ ᐊᒃᑐᐊᓂᖅᑲᕐᑎᒋᖕᒪᖕᖓᑎᒃ, ᖃᓄᑎᒋᓗ ᐊᓯᓪᓕᕐᓈᔅᑎᒋᖕᒪᖕᖓᑦ ᐅᕐᑯᓯᕙᓪᓕᐊᓕᕋᓗᐊᕐᑎᓪᓗᒍ ᐊᐅᔭᒃᑯᑦ, ᓯᕗᓂᒃᓴᒧᑦ ᖃᐅᔨᒪᔭᐅᔾᔪᑕᐅᓂᐊᕐᒪᑎᒃ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᔪᓄᑦ. ᑖᓐᓇ ᖃᐅᔨᓴᕐᓂᖅ ᐃᓕᓐᓂᐊᕐᓂᕐᑕᖅᑐᖅ ᐃᓕᓐᓂᐊᕐᑎᑦ ᐃᓚᐅᖃᑕᐅᓪᓗᑎᒃ ᐊᔾᔨᒋᖕᒋᑦᑐᒃᑯᑦ.

ᐱᕙᓪᓕᐊᓂᖓᑕ ᐅᓂᒃᑳᖓ– – 2018 ᑭᒃᓕᓯᓂᐊᕐᓂᒃᑯᑦ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐱᔪᓐᓇᐅᑎᖓ #02 023 18R-M (ᐊᕋᒍᒐᓴᒃᓄᑦ)
ᐊᕋᒍᖓᓂ 2018 ᑲᔪᓯᓚᐅᕐᑐᒍᑦ ᐃᐅᓕᑲᒥ ᖃᐅᔨᓴᕐᓂᖏᑦ ᕿᑭᕐᑕᒥ Ellesmere Island ᐊᒻᒪᓗ ᑕᕆᐅᖓᑕ Expedition Fiord ᓄᓇᖓᓂ ᕿᑭᕐᑕᒥ Axel Heiberg Island. ᖃᐅᔨᓴᕐᑎᐅᔪᑦ ᑕᖖᕐᕕᖃᓚᐅᕐᑐᑦ ᐅᓕᑲ ᓯᓚᓐᓂᐊᕐᕕᖓᓂ ᔪᓚᐃᒥ ᐊᐅᒃᐸᓪᓕᐊᓂᖓᓂᒃ ᐊᒻᒪᓗ ᓂᓚᐅᓂᖓᓂᒃ

ᖃᓂᒋᔭᖓᓂ ᓯᓚᓐᓂᐊᕐᕕᐅᑦ ᐊᕙᑎᓕᕆᔨᒃᑯᑦ ᑲᓇᑕᒥ ᓯᓚᓐᓂᐊᕐᕕᖓᑕ, ᒥᑦᑕᕐᕕᖓᓂ ᐊᒻᒪᓗ ᐅᓇᑕᕐᑐᒃᓴᒃᑯᑦ ᐃᓂᖃᕐᕕᒋᔭᖓᓂ. ᖃᐅᔨᓴᕐᓂᐅᔪᑦ ᓄᓇᖓᓂ ᑲᖏᕐᓗᐊᑕ Expedition Fiord ᕿᑭᕐᑕᖓᓂ Axel Heiberg Island ᐅᓪᓗᓄᑦ ᐅᓄᖏᑦᑐᓄᑦ ᖃᐅᔨᓚᐅᕐᑐᑦ ᐱᓇᓱᑭᓲᒃᓄᑦ ᒪᑰᒃᓄᑦ ᐃᓕᓐᓂᐊᕐᑐᓄᑦ. ᐅᓕᑲᒥ ᖃᐅᔨᓴᕆᑎᑦ ᐊᑐᕐᑕᐅᓚᐅᕐᑐᑦ dGPS, GPR ᐊᒻᒪᓗ ᐱᑭᕐᑐᖏᓐᓂᒃ ᖃᐅᔨᓴᕐᓗᑕ ᐊᐅᒃᐸᓪᓕᐊᓂᖏᓐᓂᒃ ᓄᓇᐅᑦ ᓄᖑᐸᓪᓕᐊᓂᖏᓐᓂᓕ (ᐃᓕᓐᓂᐊᕐᑎᑦ ᖃᐅᔨᓴᓚᐅᕐᑐᖅ L. ᕗᐊᑦ). ᓯᑯ ᐊᒻᒪᓗ ᐃᔾᔪᖓᓂᒃ ᖃᐅᔨᓴᒐᒃᓴᓂᒃ ᐱᕐᑲᑦᑕᓚᐅᕐᑐᑦ ᐃᓗᓕᖏᓐᓂᒃ ᖃᐅᔨᓴᕐᑕᐅᓂᐊᕐᓗᑎᒃ, ᐱᑭᕐᑐᕐᑲᕐᓂᖏᓪᓗ ᐊᒻᒪᓗ ᓂᓚᕐᑲᕐᓂᖏᑦ ᖃᐅᔨᓴᕐᑕᐅᓗᑎᒃ. ᖃᐅᔨᔭᐅᔪᑦ ᐅᓪᓗᒥᒧᑦ ᑐᑭᓯᔪᒥᓇᕐᑐᑦ, ᖃᐅᔨᓚᐅᕐᑐᒍᑦ ᐃᔾᔪᕐᒦᑦᑐᖅ ᐃᓗᓕᖏᑦ ᐊᐅᒪᓂᖓᑕ ᓄᓇᐅᑦ ᐊᔾᔨᖏᑦᑑᑕᐅᓂᖏᓐᓂᒃ ᑕᐅᓄᖓᕐᐸᓪᓕᐊᓪᓗᓂᓗ ᐊᔾᔨᖏᓕᕐᐸᓪᓕᐊᓪᓗᓂ. ᐃᔾᔪᕐᒦᑦᑐᖅ ᐃᓗᓕᖏᑦ ᐃᒪᕐᓱᒃᓂ ᖁᑦᑎᖕᓂᖅᓴᐅᓪᓗᓂ (2-5%) ᓂᕆᐅᒋᔭᐅᓪᓗᓂᓗ. ᐃᒪᕐᓲᓂᖏᑦ ᒥᑭᑦᑐᒥᒃ ᐱᑕᕐᑲᕐᓂᖓᓄᑦ 3 % ᓄᓇᖓᓂ ᒥᑭᑦᑐᒥᒃ ᐃᓚᒃᓴᕐᑲᕐᕕᐅᔪᖅ. ᐊᕋᒍᖓᓂ 2018 ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᖓ ᓄᓇᐅᑦ ᖄᖓᓃᑦᑐᖅ ᐱᕙᓪᓕᐊᓂᖓ ᐊᒻᒪᓗ ᐊᐅᒃᐸᓪᓕᐊᑎᒋᓂᖓ ᒪᓕᒃᓯᒪᓚᐅᕐᑐᖅ ᓂᒃᓚᓱᒃᓂᖅᓴᐅᑎᓪᓗᒍ ᐊᐅᔭᒃᑯᑦ (ᕗᐊᑦ ᐃᓕᓐᓂᐊᕐᑎ). ᐅᓕᑲᒥ ᖃᓂᒋᔭᖓᓂ ᐱᑕᕐᑲᕐᒪᑦ ᓄᓇᒥᖕᖠᕐᑐᒥᒃ ᓂᓚᐅᓂᕐᑲᕐᑐᒥᒃ ᐃᓗᐊᒍᑦ (ᒪᓂᕋᐅᑦ ᐊᑖᓂ ᐃᔾᔪᓂᕐᑲᕐᑐᖅ (3-10m) ᓂᓚᑐᐃᓐᓇᕐᒥᒃ) ᐊᑖᓂ 1-4 m ᑕᕆᐅᖑᑎᓪᓗᒍ ᐃᕐᑲᖓᓅᓚᐅᕐᑐᖅ, ᐱᑕᕐᑲᕐᓂᖓ ᓂᓚᒃᒥᒃ ᐊᑖᓂ ᐃᒃᐱᕐᓂᖅᓯᐃᓐᓂᖅᓴᐅᔪᖅ ᐊᐅᒃᐸᓪᓕᐊᔪᒧᑦ ᓄᖑᐸᓪᓕᐊᔪᒧᓪᓗ. ᖃᐅᔨᓴᕐᓂᕆᔭᕗᑦ ᐅᓕᑲᒥ ᓇᑎᕐᓇᖓᓂ ᐊᕋᒍᓄᑦ ᐊᕙᑎᓄᑦ ᓇᓗᓇᐃᕐᓯᓯᒪᔪᖅ ᐱᑕᕐᑲᐅᕐᓂᖓᓂᒃ “ᐅᕐᑯᓂᕐᑲᕐᓂᖏᓐᓂᒃ” ᒪᓂᕋᐅᑦ ᐊᑖᓂ ᓂᓚᐅᓂᖓ ᐊᖏᓂᖅᓴᐅᓪᓗᓂ ᖁᐊᖑᐃᓐᓇᕿᑕᐅᓂᖓ ᓄᓇᒧᑦ, ᑕᐃᒪᖓᑦ 2011 ᐊᐅᒃᐸᓪᓕᐊᓂᖓᓂᒃ ᓇᓗᓇᐃᕐᓯᒪᔪᒧᑦ ᐊᒻᒪᓗ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᖓᓂᒃ ᓄᓇᐅᑦ ᒪᓕᒃᑯᒍ ᓄᓇᐅᑦ ᐊᑖᓂ ᓂᓚᐅᓂᖓ ᐊᐅᒃᐸᓪᓕᐊᑎᓪᓗᒍ ᐃᔾᔪᓂᖓᑕ ᐊᑖᓂ 150m asl. ᐊᕋᒍᖓᓂ 2012 ᖃᐅᔨᓚᐅᕐᑐᒍᑦ ᐊᔾᔨᕐᑲᖏᑦᑐᒥᒃ ᐊᐅᒃᐸᓪᓕᐊᓂᖓᓂᒃ (250+ ᐊᐅᒃᐸᓪᓕᐊᔪᑦ ᖃᑦᑎᒃᓯᓕᕐᐸᓪᓕᐊᓪᓗᑎᒃ) ᑭᓯᐊᓂ ᐊᕋᒍᖓᓂ 2018 (ᑕᐃᒪᓐᓇᑦᑕᐅᖅ ᐊᕋᒍᖓᓂ 2013) ᐊᐅᒃᐸᓪᓕᐊᑎᒋᓂᖓ ᓱᒃᑲᐃᓐᓂᖅᓴᐅᓕᕐᑎᓪᓗᒍ ᖃᓄᐃᓕᕙᓪᓕᐊᖏᓐᓂᖅᓴᐅᓚᐅᕐᑐᖅ. ᐃᓕᓐᓂᐊᕐᑎ ᓴ ᑭᐃ ᐱᔭᕇᕐᓯᓚᐅᕐᑐᖅ ᖃᐅᔨᓴᕐᑕᒥᓂᒃ ᒪᓂᕋᕐᒥ ᓂᓚᐅᓂᖓᓂᒃ ᐃᓗᓕᖏᓐᓂᒃ ᐊᒻᒪᓗ ᓇᓗᓇᐃᕐᓯᓪᓗᓂ ᐊᔾᔨᖏᓐᓂᖏᓐᓂᒃ ᐳᕐᑐᓯᕙᓪᓕᐊᓪᓗᓂ ᓄᓇᒥ ᐊᐅᒃᐸᓪᓕᐊᑎᒋᓂᖓᓂᒃ. ᖃᐅᔨᒪᓇᓱᒃᓂᖅ ᐱᕙᓪᓕᐊᓂᖓᓂᒃᓗ ᐊᐅᒃᐸᓪᓕᐊᓂᖓᓂᒃ ᖁᐊᖑᕐᐸᓪᓕᐊᓂᖓᓂᒃᓗ ᐃᓕᓐᓂᐊᕐᑎᐅᑦ ᖃᐅᔨᓴᓚᐅᕐᑕᖓ L. ᕗᐊᑦ. ᐊᒻᒪᓗ ᓇᓗᓇᐃᕐᑎᑉᐊᓪᓕᐊᓪᓗᑎᒍ ᐊᐅᒃᐸᓪᓕᐊᓂᖏᑦ ᕗᐊᑦ ᐊᑐᓚᐅᕐᒥᔪᖅ ᖃᖓᑦᑕᕐᑎᑕᐅᓯᒪᔪᒃᑯᑦ ᓇᓗᓇᐃᕐᓗᓂᒋᑦ ᓇᒦᒧᒻᒪᖓᑕ ᐊᒻᒪᓗ ᓄᓇᖓ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᖓᓂᒃ ᖃᐅᔨᓴᕆᑎᒋᓗᒋᑦ. ᖃᐅᔨᓴᕐᓂᐅᒃᑲᓐᓂᓚᐅᕐᑐᑦ ᓄᓇᒥᒃ ᐊᑖᓄᑦ ᕿᓂᕆᑎᒥᒃ ᓂᓚᐅᓂᖏᓐᓂᒃ ᐊᒻᒪᓗ ᓂᓚᕐᑲᕐᓂᖏᓐᓂᒃ, ᖃᐅᔨᓴᒐᒃᓴᓂᒃᓗ ᐱᕐᑲᑦᑕᕐᓗᑎᒃ ᐊᒻᒪᓗ ᖃᖓᑦᑕᓪᓗᑎᒃ ᖃᐅᔨᓴᕐᓗᑎᒃ.

ᐊᕋᒍᖓᓂ 2019 ᖃᐅᔨᓴᕐᓂᐅᓂᐊᕐᑐᖅ.

ᑕᓐᓇ ᖃᐅᔨᓴᕐᓂᐅᔪᖅ ᑭᖑᓪᓕᕐᐹᖑᓕᕐᑐᖅ ᐃᓯᓕᓐᓂᐊᕐᑐᖅ 2020 ᖃᐅᔨᓴᕐᓂᖅ. ᑐᕋᐅᔪᑦ 2019 ᐱᔭᕇᕆᒪᓪᓗᑎᒍ ᖁᐊᖑᓂᖓ ᓄᓇᐅᑦ ᓂᓚᐅᓂᖏᓪᓗ ᐱᓗᐊᕐᑐᒥᒃ ᐃᒃᐱᒃᓇᐅᑎᕐᑲᕋᔭᕐᓂᖓ ᐊᐅᒃᐸᓪᓕᐊᔪᒧᑦ. ᐊᕋᒍᖓᓂ 2019 ᖃᐅᔨᓴᕐᓂᐅᔪᖅ ᑐᕌᕐᑲᕐᓂᐊᕐᑐᖅ ᐅᑯᓂᖓ: (1) ᐊᓯᓪᓕᕐᐸᓪᓕᐊᔪᑦ ᓄᓇᐅᑦ ᖄᖓᓂ ᐊᒻᒪᓗ; ᐃᒃᐱᒃᓇᐅᑎᓂᖏᑦ ᓄᓇᖓᓄᑦ ᐊᓯᓪᓕᕿᑕᐅᓂᖓᓄᑦ, (2) ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᐅᔪᑦ ᓂᓚᐅᓂᖏᑦ ᐊᐅᒃᐸᓪᓕᐊᓂᖏᓐᓄᑦ ᐊᒻᒪᓗ (3) ᖃᐅᔨᓴᕐᓂᖅ ᐃᓗᓕᖏᓐᓂᒃ ᒪᓂᕋᕐᒦᑦᑐᑦ ᓂᓚᐅᓂᖓ ᓴᕿᑉᐊᓪᓕᐊᓂᖓ. ᓴᕿᑉᐸᓪᓕᐊᓂᖓ ᖃᐅᔨᓴᕐᑕᐅᓂᐊᕐᑐᖅ ᑎ. ᓚᓯᐅᓪᓗᑦ. ᐆᒃᑐᕋᕐᐸᒃᑐᓂ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᐅᔪᓂᒃ ᓄᓇᐅᑦ ᖄᖓᓂᑦ ᑐᕌᓪᓗᐊᑕᐅᓪᓗᓂ ᐊᒻᒪᓗ ᓇᓗᓇᐃᕐᓯᔾᔪᑕᐅᓪᓗᓂ ᐊᒃᑐᐊᓂᕆᔭᕐᑎᑦ ᓯᓚᐅᑦ, ᓄᓇᐅᓪᓗ ᖄᖓᓂ ᖁᐊᖑᓂᖓᑕᓗ ᓄᓇᐅᑦ. ᖃᐅᔨᓴᕐᓂᖅ ᐸᕐᓇᐅᑎᕐᑲᕐᑐᒧᑦ ᑲᖏᕐᓗᖓᑕ ᓄᓇᖓᓂ Expedition Fiord area ᕿᑭᕐᑕᒥ Axel Heiberg Island (79º25N; 90º43’W) ᐊᒻᒪᓗ ᐅᓕᑲ ᖃᓂᒋᔭᖓᓂ ᕿᑭᕐᑕᒥ Ellesmere Island (79º59’N; 85º49’W). ᖃᐅᔨᓴᕐᓂᕗᑦ ᓂᕈᐊᕐᑕᐅᓚᐅᕐᑐᑦ ᖃᐅᔨᓴᕐᕕᐅᔪᒪᓪᓗᑎᒃ ᐊᕋᒍᖓᓂ 2012 ᐊᔾᔨᒋᔭᐅᓂᖏᓐᓄᑦ ᐊᓯᖏᓐᓄᑦ ᓄᓇᐅᔪᓄᑦ ᐅᑭᐅᒃᑕᒃᑐᒥ. ᑖᒃᑯᐊ ᖃᐅᔨᓴᕐᕕᐅᔪᑦ ᓂᕈᐊᕐᑕᐅᓚᐅᕐᑐᑦ ᐱᔪᑎᒋᓪᓗᒍ ᐅᐸᒃᓴᐅᓂᖏᓐᓄᑦ, ᑎᑎᕋᕐᑕᐅᓯᒪᓂᖏᓐᓄᑦ, ᖃᐅᔨᓴᕐᕕᒃᑕᕐᑲᕐᓂᖓᓄᓪᓗ. ᑖᓐᓇ ᖃᐅᔨᓴᕐᓂᖅ ᕿᒥᕈᓂᐊᕐᑐᑦ ᐃᒃᐱᒃᓂᖅᓯᕋᐃᑎᒋᓂᖏᓐᓂᒃ

ᖁᐊᖑᓂᖓ ᓄᓇᐅᑉ ᐅᖁᓯᕙᓪᓕᐊᑎᓪᓗᒍ ᓄᓇᐅᑉ ᕿᖓᓂ ᖃᓄᑎᒋᓗ ᑎᑭᐅᒪᑎᒌᒃᒪᖕᒑᑦ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᐅᔪᓪᓗ ᓄᓇᐅᑉ ᕿᖓᓄᑦ. ᑕᕝᕙᓂ ᖃᐅᔨᓴᕐᓂᕐᒥ ᓇᓗᓇᐃᕐᓯᔪᒪᔪᒍᑦ ᑭᒃᓕᒋᔭᖏᓐᓂᒃ ᐊᓯᓪᓕᕐᕈᓂ ᐅᑎᒃᑲᓐᓂᕈᓐᓇᐃᓕᒐᔭᕐᓂᖓᓂᒃ ᐅᕙᓂᐊᕈᑎᖓᓂᑦ, ᐅᖃᐅᓯᐅᒐᔭᕐᑐᓂᒃᓗ (ᑐᕋᖓᓂᔭᕋ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᑮᓇᐅᔭᕐᑖᕈᑕᐅᓪᓗᓂ). ᐊᕋᒍᖓᓂ 2019 ᒪᕐᕿᒃᓂᒃ ᐊᐱᖁᑎᖃᕐᓂᐊᕐᑐᖓ: (1) ᓄᓇᐅᑉ ᕿᖓᓃᑦᑐᖅ ᐊᐅᐸᓪᓕᐊᓂᖓᓄᑦ ᓄᖃᖓᑎᑦᑎᓂᖅᓴᐅᕙ ᓄᓇᐅᑉ ᖁᐊᖑᓂᖓᓂᒃ? ᐊᒻᒪᓗ, (2) ᓂᓚᐅᑉ ᓴᕿᑉᐸᓪᓕᐊᔪᑦ ᐊᐅᒃᐸᓪᓕᐊᑎᕆᓂᖏᑦ ᐊᔾᔨᕆᔭᐅᖏᓚᑦ ᐊᓯᖏᓐᓄᑦ ᓄᓇᒥ ᖁᐊᖑᓂᖓᓄᑦ? ᖃᐅᔨᓴᕐᓂᐊᕐᐳᑦ ᐊᕋᒍᖓᒥ 2019 ᐱᖃᓯᐅᑎᓗᒍ ᐆᒃᑐᕋᕐᓗᑕ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᐅᔪᓂᒃ ᓄᓇᐅᑉ ᕿᖓᓂ ᐊᑐᕐᓗᒋᑦ ᖃᐅᔨᓴᕈᑎᑦ ᑕᒻᒪᓅᒃᑯᑎᑦ ᒪᓂᕋᐅᓪᓗ ᓄᓇᐅᑉ ᐃᓗᐊᓄᑦ ᖃᐅᔨᓴᕈᑎᑦ. ᑖᒃᑯᐊ ᑎᑎᕋᕐᓯᒪᔪᑦ ᖃᐅᔨᓴᕈᑕᐅᔪᑦ ᐱᖃᓯᐅᔾᔭᐅᓂᐊᕐᑐᑦ ᓄᓇᓕᓐᓂᕐᒧᑦ ᑎᑎᕋᕐᑕᐅᕙᓪᓕᐊᔪᓄᑦ ᐊᑐᕐᑕᐅᓗᑎᒃᓗ ᖃᖓᑦᑕᕐᑎᑕᓯᒪᔪᒃᑯᑦ ᐊᔾᔨᓕᐅᒐᐅᔪᓄᑦ, (b) ᖃᐅᔨᓇᓱᒃᓗᒍ ᓄᓇᐅᒃ ᕿᖓᓃᑦᑐᖅ ᐊᐅᒃᐸᓪᓕᐊᓂᖓ ᐊᒻᒪᓗ ᐆᕐᑐᕐᓗᒍ ᐅᖁᓯᕙᓪᓕᐊᑎᕆᓂᖓ ᐊᒻᒪᓗ ᒪᓴᐅᓂᖓ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᖓ ᐊᐅᔭᒃᑯᑦ. ᑲᑎᑦᑎᓗᑕ ᖃᐅᔨᓴᒐᒃᓴᓂᒃ ᓂᓚᒃᓂᒃᓗ ᐱᖃᑦᑕᕐᓗᑕ ᓄᓇᐅᑉ ᕿᖓᓂᑦ ᐊᒻᒪᓗ ᕿᖓᓂᑦ ᖁᐊᖑᓂᖓᑕ, ᐊᒻᒪᓗ (c) ᖃᖓᑕᓗᑕ ᑕᑯᓇᒃᓗᒋᑦ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᐅᔪᑦ ᓄᓇᖓᓂ Fosheim Peninsula. ᐃᓚᒋᔭᖓ ᑲᔪᓯᑎᐊᓚᐅᖏᑦᑐᖅ ᐊᕋᒍᖓᓂ 2018 ᐊᑐᕐᑕᐅᓇᓱᒃᓗᓂ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᓂᖓᓄᑦ ᖃᐅᔨᓴᕈᑎ ᐊᐅᒃᐸᓪᓕᐊᓂᖓᓄᑦ ᖃᐅᔨᓴᕈᑎ. ᐋᕿᒋᐊᕐᑕᐅᓯᒪᓕᕐᓗᓂ ᖃᕋᓴᐅᔭᖏᑦ ᖃᐅᔨᓴᕈᑎᐅᑉ ᐱᒋᐊᕐᑕᐅᒃᑲᓐᓂᓇᐊᕐᓂᐊᕐᓗᓂ.

ᐱᓪᓚᕆᐅᑎᒋᓂᖓ:

ᑖᓐᓇ ᖃᐅᔨᓴᕐᓂᖅ ᐃᑲᔫᑕᐅᓂᐊᕐᑐᖅ ᑐᑭᓯᔭᐅᒃᑲᓐᓂᕐᓗᓂ ᓄᓇᐅᑉ ᖁᐊᖑᓂᖓ ᐊᒻᒪᓗ ᒪᓂᕋᐅᑉ ᓂᓚᐅᓂᖓ ᖁᑦᑎᒃᑐᒥ. ᑐᑭᓯᔾᔪᑕᐅᕙᕈᕐᑐᖅ ᖃᐅᔨᒪᔭᐅᓚᐅᖏᑦᑐᓂᒃ ᐱᒋᐊᕐᕓᐅᓯᒪᔪᓂᒃ ᐱᑐᖃᐅᑎᒋᓂᖏᓐᓂᒃᓗ ᖁᐊᖑᓂᖓ, ᖃᓄᑎᒋᓗ ᐊᓯᓪᓕᕐᐸᓪᓕᐊᑎᒋᓂᖓ ᐊᒻᒪᓗ ᐃᒃᐱᒃᓇᐅᑎᒐᔭᕐᓂᖓ ᓂᓚᐅᓂᖓ ᓄᓇᒧᑦ ᐊᓯᓪᓕᕈᑕᐅᓪᓗᓂ. ᖃᓄᑎᒋ ᐅᖁᓯᕙᓪᓕᐊᑎᒋᓂᖓ ᖁᑦᑎᒃᑐᒥ ᓂᕆᐅᒋᔭᐅᓂᖓ ᐊᑐᑎᖃᕐᓂᐊᕐᒪᑦ ᐊᕙᑎᖓᓄᑦ ᓄᓇᒧᓪᓗ. ᑖᓐᓇ ᖃᐅᔨᓴᕐᓂᕗᑦ ᐱᓪᓚᕆᐅᔾᔪᑎᖃᕐᑐᖅ ᐱᔾᔪᑎᒋᓪᓗᒍ ᐅᔭᕋᒃᑕᕈᒪᔪᑦ ᐅᓄᕐᓯᕙᓪᓕᐊᑎᓪᓗᒋᑦ. ᑕᕗᖓᕐᓯᕗᖓ ᐅᓂᒃᑳᓕᐊᖑᓚᐅᕐᑐᒥᒃ ᓂᓚᒃᒥᒃ ᖃᐅᔨᓴᕐᓂᐅᓚᐅᕐᑐᖅ ᓄᓇᖓᓂ Fosheim Peninsula.

ᕗᐊᐃᓐ ᐳᓚᕐᑦ Wayne Pollard