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2016

doi:10.4095/299381

This publication is available for free download through GEOSCAN (http://geoscan.nrcan.gc.ca/).

Recommended citation
Sanborn-Barrie, M., Ford, A., Hillary, E., Tschirhart, V.L., Tremblay, T., and Maharaj, J., 2016. Report of activities for the GEM-2 Boothia Peninsula-Somerset Island project: Integrated Geoscience of the Northwest Passage; Geological Survey of Canada, Open File 8128, 8 p. doi:10.4095/299381

Publications in this series have not been edited; they are released as submitted by the author.

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Foreword

The Geo-mapping for Energy and Minerals (GEM) program is laying the foundation for sustainable economic development in the North. The Program provides modern public geoscience that will set the stage for long-term decision making related to investment in responsible resource development. Geoscience knowledge produced by GEM supports evidence-based exploration for new energy and mineral resources and enables northern communities to make informed decisions about their land, economy and society. Building upon the success of its first five-years, the program has been renewed (GEM-2) until 2020 to continue producing new, publically available, regional-scale geoscience knowledge in Canada's North.

During the summer 2016, GEM-2 successfully carried out 17 research activities that included geological, geochemical and geophysical surveying. Many of these were undertaken in collaboration with provincial and territorial governments, northerners and their institutions, academia and the private sector. GEM-2 will continue to work with these key collaborators as the program advances.

Introduction

The GEM-2 activity Boothia Peninsula-Somerset Island ***Integrated Geoscience of the Northwest Passage*** (Figure 1) will involve bedrock mapping supported by geophysical, geochronological and geochemical datasets with targeted surficial studies across Boothia Peninsula and Somerset Island. The area is an under-explored frontier region where knowledge stems from 1963 and 1986 mapping, without benefit of aeromagnetic constraints or modern U-Pb geochronology. New mapping and value-added datasets will significantly upgrade the outdated geoscience framework of this area, expand the impact of the mainland GEM-2 Rae Thelon Activity findings (Berman et al. 2014; Berman et al., 2016), and provide relevant data and knowledge to an isolated region of Nunavut that, due to global warming and the resulting increased shipping, will increasingly be exposed to issues related to resource assessment and economic development.

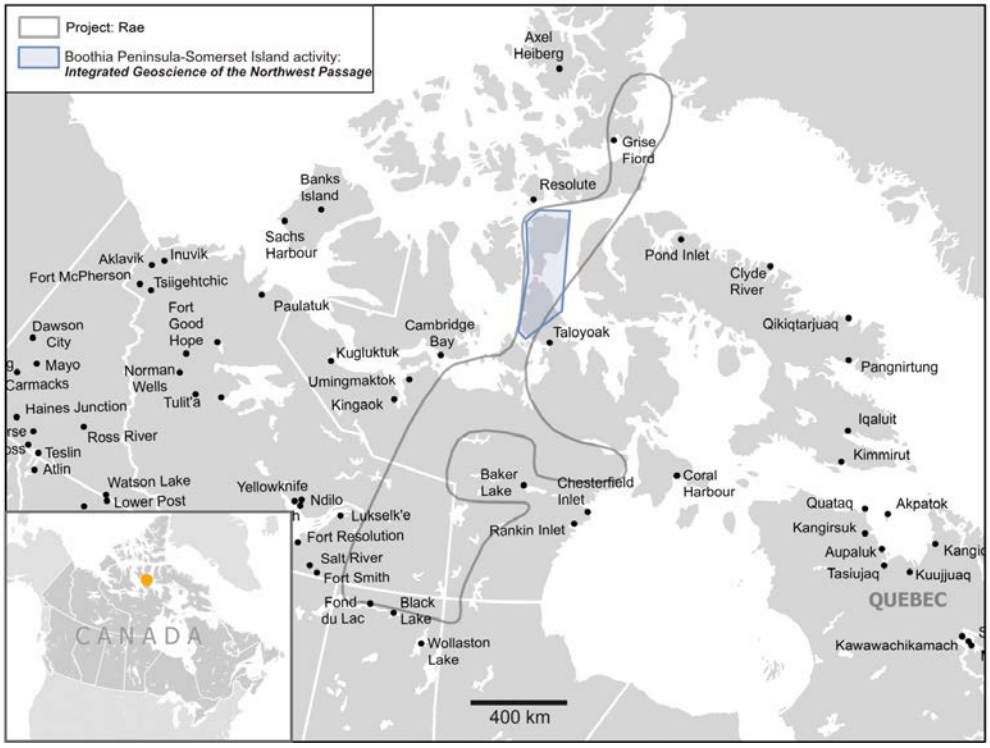

Figure 1. Map of Canada's North highlighting the Rae region of interest (solid grey outline) within which the Boothia Peninsula-Somerset Island activity is located (blue outline). The Geoscience Field School described in this report was located 3.5 km north of Taloyoak.

Through its commitment to maximizing the benefits of geoscience research to northerners, GEM-2 supported a pilot field school initiative at an early stage of the Boothia Peninsula – Somerset Island activity, for which bedrock mapping is planned for 2017 and 2018. The **Taloyoak Geoscience Field School** was designed to stimulate and strengthen interest in relevant aspects of geoscience by providing Northerners an opportunity to gain a 'hands-on' sense of methods used to gather geological data, and a venue to learn how geoscience data can be accessed and used for planning and decision making, in a familiar setting.

Methodology

Planning related to a community field school was initiated in December 2015 through bilingual (English and Inuktitut) introductory letters from Natural Resources Canada (NRCan) to the Hamlet of Taloyoak and Spence Bay Hunters' and Trappers' Organization (HTO). Swift, positive support for an experiential learning opportunity focused on the land was communicated to NRCan by a representative from the HTO, who shared the concept with members of the HTO board at its January 2016 meeting. NRCan was invited to Taloyoak, NU in mid-March 2016, to deliver presentations to the Hamlet and HTO, to respond to questions and concerns the HTO had, particularly in regard to mining activities, and to gain community input on where a temporary, low-impact, tent-based field school could be located to ensure accessibility to as many interested residents as possible. The mid-March visit coincided with the school Science Fair, whose organizers provided an opportunity to announce the concept of a summer geoscience field school to all science students and many of their parents. A Public Meeting held on the evening of March 16, 2016, was used to describe the initiative, receive input and answer all related questions.

Support for the initiative was communicated by the Hamlet during the visit in March 2016, and endorsement was more formally provided by the HTO on May 16, 2016. Application to the Nunavut Planning Commission was circulated and on June 8, 2016 determined to be exempt from further screening due to its nature and lack of concern regarding any negative impacts. This paved the way for a Letter of Agreement with the Hamlet of Taloyoak to be drafted as a means to hire local personnel to assist in set-up, take-down and co-ordinate storage of equipment after the field school so that it would be available for use during mapping in 2017 and 2018.

NRCan – Canada-Nunavut Geoscience Office (C-NGO) staff arrived the afternoon of August 2, 2016 and over the next two days with the support of the Hamlet set up a low-impact tent camp on an esker located adjacent to German Lake (see Fig. 4a), posted bilingual notices and brochures around town, updated information on the Taloyoak Community Facebook page and made arrangements for information to be announced during noon-time community radio programming. A presentation at the school to grades 8 through 12 teachers and teaching assistants outlined the scope and intent of the planned activity, and its relevance to inspiring youth to realize post-secondary educational opportunities and the variety of career opportunities related to scientific research in the north.

The Taloyoak Geoscience Field School held a full day Open House on Friday August 5, and hosted more than 160 residents of all ages from Friday August 5 through to the morning of Wednesday August 10, 2016.

Materials:

All rock samples used for demonstration purposes originated from Nunavut, with specimens from Baffin Island, Committee Bay belt, Thelon tectonic zone, and Southampton Island (Fig. 2). Mineral specimens from the Government of Nunavut's Rocks and Minerals of Nunavut Teaching Kit, distributed to schools across Nunavut in 2013, complimented a GSC mineral collection. Aerial photographs of distinctive landmarks near Taloyoak and Gjoa Haven were used for stereoscopic viewing to maximize the impact on participants to whom these landmarks would be familiar.

Figure 2. Plain-language descriptions and explanations of samples from across Nunavut allowed self-directed individual-paced learning.

Topics Covered:

Aspects of geoscience relevant to residents of Taloyoak provided the foundation of the field school.

a) ***Why & How We Map Rocks: The Story They Tell:***

- examples of northern maps were used to illustrate the different types of information portrayed on maps, including geology (Fig. 3a)
- everyday uses of a geological map
- how naturally occurring elements combine to form minerals, and naturally occurring minerals combine to form rocks (Fig. 3b)
- the insight rocks provide as one of the few recorders of events in the distant past (Fig. 3c), providing a record of volcanism (pyroclastic breccia from Cumberland Peninsula), the existence of warm oceans (marble from Cape Dorset); and quiescent ocean basins (iron formation from Mary River, Baffin Island), not only before humans existed, but back in time some three billion years.

b) ***Ancient Ice Sheets: Why We Care:***

- elements of geomorphology, glacial geology and cartography were integrated through examination of glacial features, topographic maps, satellite images, airphotos and surficial geology maps (Dyke, 1984; Tremblay et al. 2007) such that the fluctuating presence of large ice sheets during the last 2 million years was easily envisaged by participants through observation of swarms of highly elongated drumlins, or flutings, in the Taloyoak area.
- limestone erratics underfoot illustrated how NE-flowing ice transported Ordovician carbonate rocks from the Rasmussen Basin over Boothia Peninsula, and provided a relevant

example of how rocks and minerals from economic deposits may be similarly dispersed

- location of the field school (Fig. 4a) on an esker deposited from meltwaters flowing under the glacier during its retreat, highlighted the importance of ancient ice sheets as a source of sand and gravel, critical for the construction of community roads and airstrips, while the presence of raised beaches were a reminder of a long history of sea-level change (Fig. 4a,b).

Figure 3. Rocks and minerals. a) recognizing the value of maps to convey different types of information; b) appreciating the link between naturally occurring elements, combinations of elements (minerals) and combining minerals to form rocks; c) learning of events in Nunavut's ancient past from its rock record.

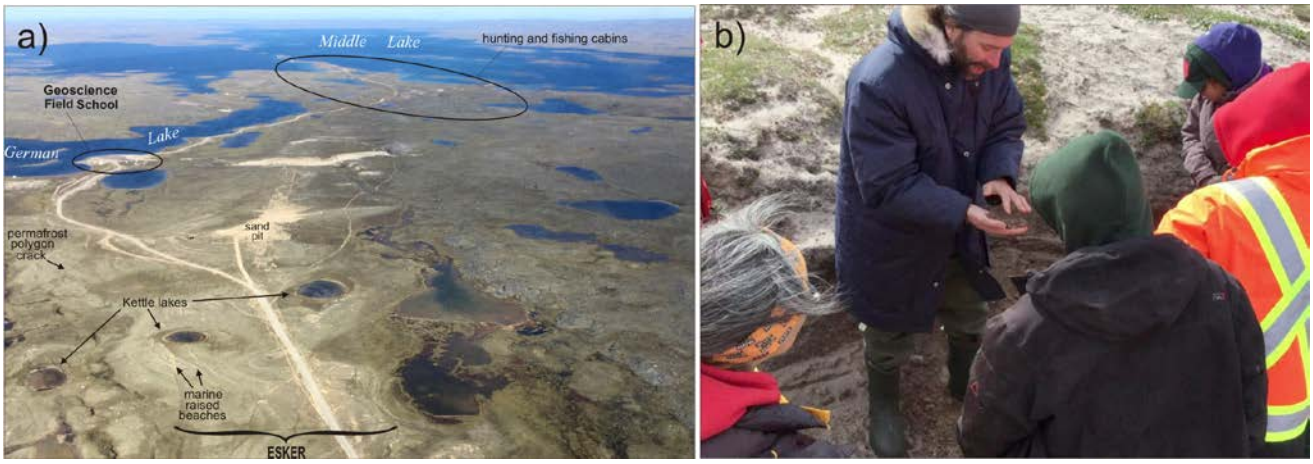

Figure 4. Glacial geology. a) site of the Taloyoak Geoscience Field School on an esker, pitted by kettle lakes (formed by large "cubes" of glacial ice entrained in the esker sediment and subsequently melted), and transected by raised beaches marking marine retreat following deglaciation, provided a natural classroom for integrated glacial studies; b) examining marine littoral sediments composed of fine sand alternating with plant macrorest layers, in a roadcut section.

c) ***Geophysics: What It Reveals***:

- provided an overview of publically available potential field datasets (gravity and magnetics), interpretation techniques for each dataset, and a brief overview of instrumentation (gravimeter and magnetic susceptibility meter) for conducting ground surveys and follow-up field work (Fig. 5a)
- provided an opportunity to use a magnetic susceptibility meter to measure various rock samples (Fig. 5b) that were correlated to magnetic field images over their land
- given that the Aston Bay Copper project on Somerset Island, Nunavut - the closest exploration camp to Taloyoak - relies heavily on gravity data for exploration, a demo ground gravity survey over a buried object was undertaken and the collected data processed to illustrate the value of gravity as a low-impact method to locate and identify a buried object (Fig. 5c)

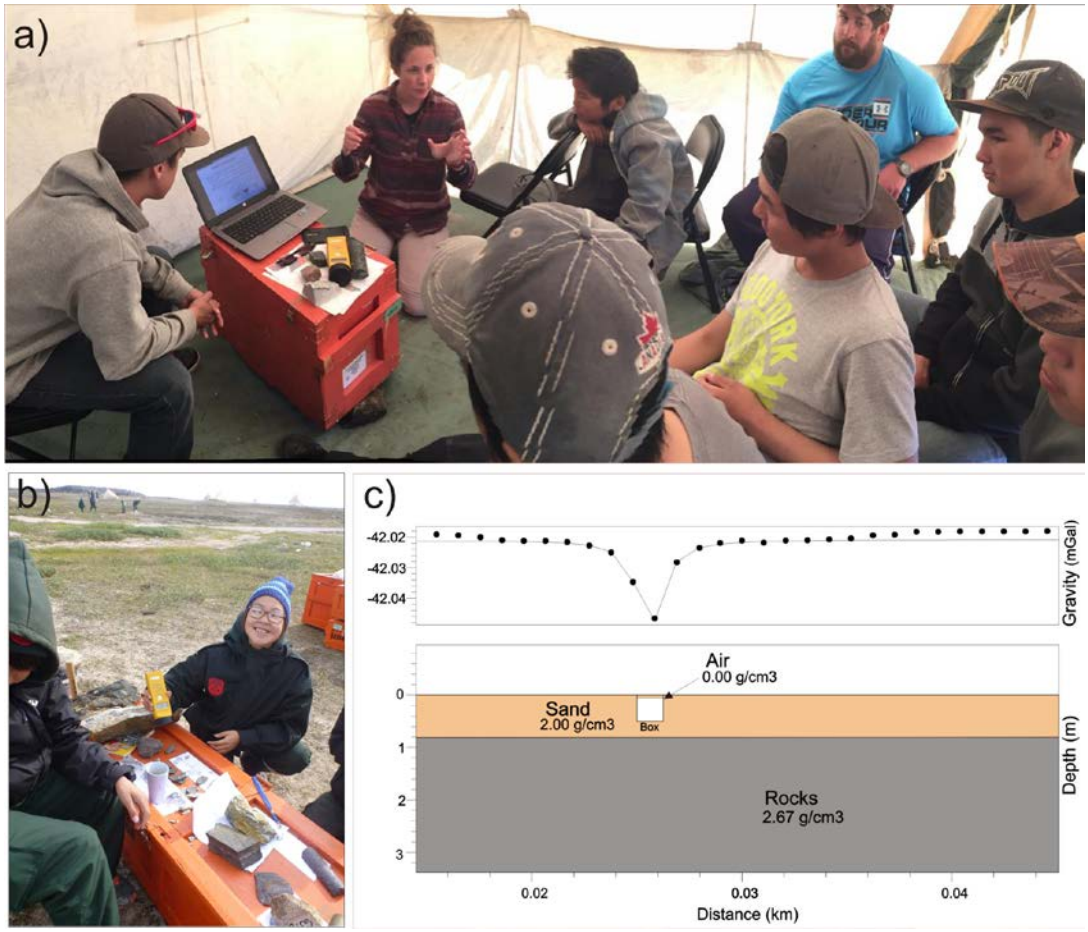

Figure 5. Geophysical surveys: what they reveal. a) overview of publically available geophysical datasets and methods; b) measuring the magnetic susceptibility of various rock samples; c) processed data for a simple gravity survey over a buried object.

d) ***Mapping in a Digital Age (Geographic Information System GIS):***

- overview of what a GIS specialist does in an office setting, and in a field setting
- "hands-on" exploration of a database of maps of different kinds of geoscience information from the Taloyoak area (e.g. geology map) using ArcGIS software, allowing groups of three participants to "explore" for ~20-30 minutes

- guidance in selecting features and use of basic tools in ArcGIS, such as pan, zoom, measure, identify and find, to locate the homes of friends and family and to quantify familiar objects, such as the airstrip and Northern store.
- various datasets were introduced through an exercise which challenged each GIS team to determine the smallest object visible on different types of digital images of the land.

e) ***Geocaching using GPS***:

- hands-on introduction to geocaching (Fig. 6) using a hand-held Global Positioning System (GPS) unit, with special emphasis on entering co-ordinates and successfully navigating a geocaching course
- three course configurations were ~3.7 km long with a total of six caches which held mineral specimens for participants to find and keep
- responsible land use practices were reinforced through a bonus challenge issued to collect any trash encountered on the route, with prizes awarded for teams who, not only navigated the course successfully, but left the environment cleaner than they found it

Figure 6. Geocaching using GPS.

Key Outcomes

The 2016 Taloyoak Geoscience Field School successfully engaged residents of all ages in aspects of geology relevant to their community. It allowed dialogue over a sustained period of time in a field setting proximal to Taloyoak, thereby maximizing accessibility for all. It facilitated understanding of the gap in geological knowledge created by out-of-date datasets such as geology maps, and became an important forum for discussing field work planned in the area over the course of the *Boothia Peninsula-Somerset Island* activity.

The tent-style setting provided a hospitable and receptive destination for residents of all ages to come together to learn and appreciate aspects of their land that formerly were unfamiliar to them. The respect and commitment demonstrated by NRCan–CNGO staff throughout the planning and execution of this initiative strengthened support for and trust of GEM-2 operations, providing a stronger foundation on which to advance activities related to updating geoscience knowledge across this region.

The geophysics module effectively communicated the environmentally low-impact nature of various geophysical surveys to reveal aspects of Earth's interior, while minimizing the human footprint on the land. Following a presentation of magnetic data, participants stated their appreciation that they now had a better understanding of the type and significance of data acquired by aircraft many residents had noticed over their community. The importance of digital data management in this digital age brought an increased awareness of career opportunities in this field.

The scientific perspective communicated in all aspects of geoscience added to the existing local and traditional knowledge of landmarks, natural materials, topography and travelling routes, in a way that illustrated how both perspectives can co-exist. This particularly excited youth who understood that following a career path in geoscience need not exclude traditional learning and living on the land.

Acknowledgments

We thank the residents of Taloyoak who took the time to visit the Taloyoak Geoscience Field School and acquire greater knowledge and appreciation of the land we share. We gratefully acknowledge the support of Jimmy Oleekatalik, Mayor Joe Ashevak, SAO Murtaza Gurmani, Joseph Quqqiaq, Larry Banks, Julie Sarasin, former SAO Greg Holitzki, Kristine, Dennis and Charlie Lyall, and appreciate the interest and thoughtfulness of Cathy and Dave Williams. Logistical support essential to delivery of this initiative was provided by Polar Continental Support Program. Kate Clark and Danny Wright are thanked for their editorial reviews.

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