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# Report of activities for the GEM-2 Boothia Peninsula–Somerset Island Project: integrated geoscience of the Northwest Passage, Nunavut

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# Report of activities for the GEM-2 Boothia Peninsula–Somerset Island Project: integrated geoscience of the Northwest Passage, Nunavut

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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 responsible land-use and 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, GEM has been renewed until 2020 to continue producing new, publicly available, regional-scale geoscience knowledge in Canada's North.

During the 2017 field season, research scientists from the GEM program successfully carried out 27 research activities, 26 of which will produce an activity report and 12 of which included fieldwork. Each activity included aspects of geological, geochemical and geophysical surveying. These activities have been undertaken in collaboration with provincial and territorial governments, Northerners and their institutions, academia and the private sector. GEM will continue to work with these key partners as the program advances.

## Introduction

The Boothia Peninsula – Somerset Island area is an under-explored frontier region where knowledge stems from 1962 (Blackadar, 1967) and 1986-1992 (Frisch, 2011) geological mapping, undertaken without benefit of aeromagnetic constraints or extensive U-Pb geochronology (Frisch and Hunt, 1993). The GEM-2 activity on Boothia Peninsula-Somerset Island, ***Integrated Geoscience of the Northwest Passage*** (Fig. 1), is building on this historical foundation through modern-concept bedrock mapping supported by high-resolution geophysical and geochronological data sets. Acquisition of isotopic and geochemical data for representative samples will allow the exposed Precambrian bedrock to be time-calibrated and characterized with respect to tectonic affinity and crust-mantle interaction. Targeted surficial studies and research into the energy potential of Paleozoic strata are also in progress through participation by the Canada-Nunavut Geoscience Office.

New mapping and value-added datasets will significantly upgrade the geoscience framework of this area, provide precise age determinations and lithogeochemical characterization of its main map units, expand impact of the mainland GEM-2 Rae Thelon tectonic zone activity (Fig. 2) findings 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.

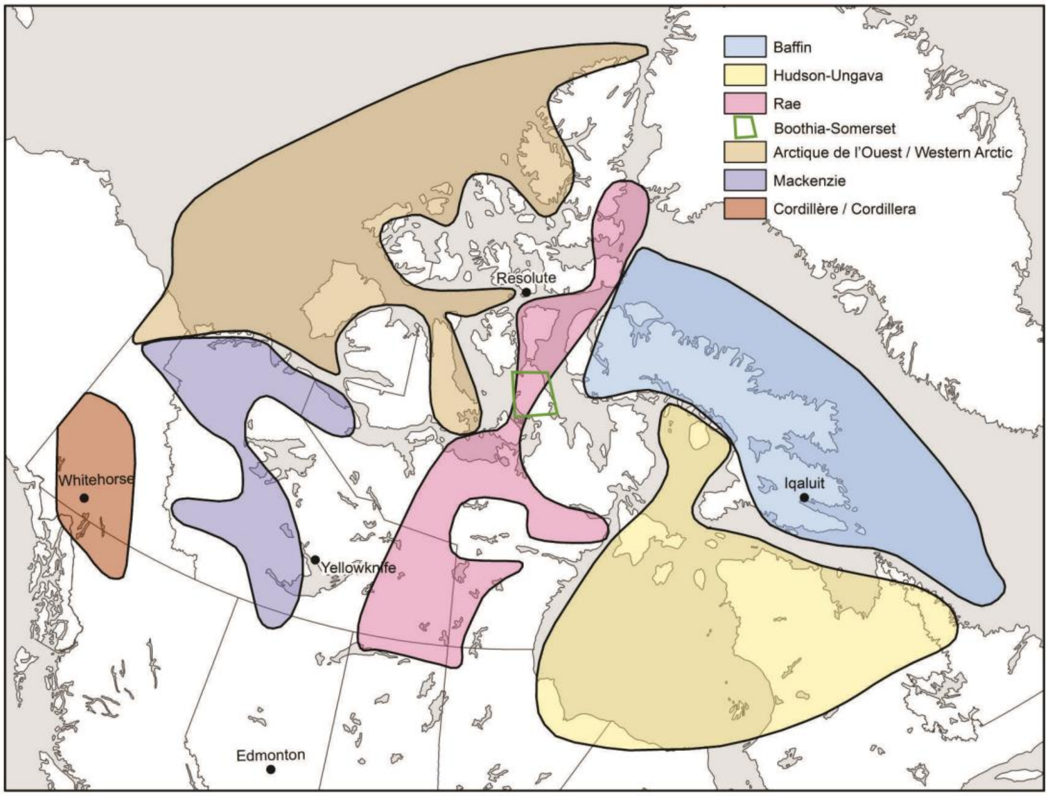

Figure 1. Map of Canada's North highlighting the six GEM-2 regions of interest, which includes the Rae region (pink). Mapping as part of the GEM-2 Boothia Peninsula-Somerset Island activity, described in this report, took place in 2017 within the area indicated in green.

## Regional Setting

Activities in Nunavut during phase II of the GEM program (2014-2020) are focused in the western part of the territory with field-based integrated geoscience projects in the south Rae (Acosta-Gongora et al., 2015; Percival et al., 2016; Regis et al., 2016), Thelon tectonic zone (Berman et al., 2015a, 2015b, 2016, in prep.) and Boothia Peninsula-Somerset Island (Sanborn-Barrie et al., 2016*a,b*) regions (Fig. 2). All three of these GEM-2 activities are seeking to upgrade data and knowledge of the Archean western Rae craton and its tectonometamorphic reworking during subsequent orogenic events, particularly involving the Archean Slave craton to the west and, to the south of Slave craton, the Buffalo Head terrane (Fig. 2).

The architecture of western Rae craton is complex, having been imposed through events dating back to at least 3.2 Ga (Tersmette, 2012; Davis et al., 2013, 2014) and potentially back to ca. 3.6 Ga (Thériault et al., 1994). Its evolution involved at least three distinct tectonomagmatic events including the 3.2-2.66 Ga Rae orogeny; 2.5-2.35 Ga Arrowsmith orogeny; and 2.0-1.9 Ga Thelon tectonic (and, to the south, the Taltson magmatic) events, with potential thermo-structural overprint at 1.88-1.79 Ga, possibly related to far-field effects of the Trans-Hudson orogeny. The Boothia-Somerset region was further affected by shortening during the ca. 420-370 Ma Caledonian orogeny (Okulitch et al., 1986) and possibly later (ca. 25-10 Ma) extensional faulting related to the Eurekan orogeny. Collectively, these resulted in exposure of a north-trending belt of Precambrian rocks, historically designated the Boothia uplift, arch and/or horst (Kerr and Christie, 1965; Kerr, 1977), in contact to both the east and west with folded and tilted, Mesoproterozoic and Paleozoic strata (Cornwallis Fold Belt).

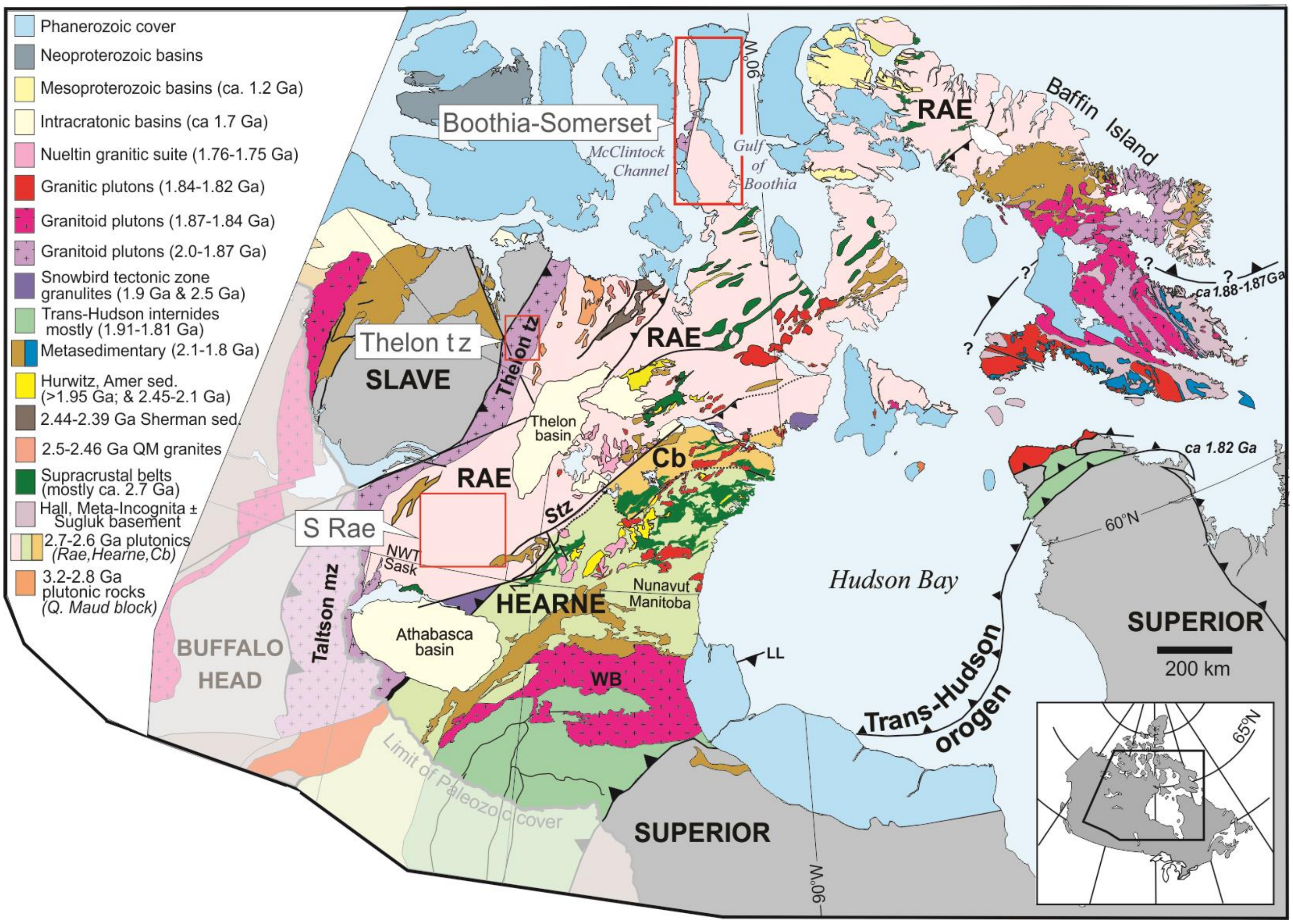

Figure 2. Geological map of northern Canada showing major tectono-magmatic elements and the location of three field-based GEM-2 activities focussed along western Rae craton. Abbreviations: Cb=Chesterfield block; LL=Lynn Lake suture; mz=magmatic zone; Stz=Snowbird tectonic zone; tz=tectonic zone, WB= Wathaman batholith.

## Previous Work

Much of Boothia Peninsula's crystalline rocks were last mapped in 1962 (Blackadar, 1967) when its Precambrian exposures were very broadly subdivided into mafic and felsic gneisses and granitic rocks. This largely textural classification at 1:506 880 scale provided minimal insight into protoliths or crustal affinity which, in turn, has long hampered understanding of the tectonic evolution of this region and prevented its integration into regional tectonic models. Timing constraints were limited to three K-Ar ages between 1.7 – 1.6 Ga, determined on biotite from gneisses and granite (Blackadar, 1967).

The University of Ottawa led several mapping projects from 1964 - 1976 that focused on Somerset Island's extensive Phanerozoic exposures (Dineley and Rust, 1968; Dixon, 1974; Jones and Dixon, 1975), and included structural mapping and metamorphic characterization of several transects through its basement gneisses (Giguere, 1968; Brown et al., 1969).

The GSC's Operation Boothia, initiated in 1975, was intended to provide new maps of all of Boothia Peninsula and Somerset Island at 1:250 000 to 1:125 000 scale (Kerr, 1976), with fieldwork targeted at folded and faulted Phanerozoic strata (Cornwallis fold belt) adjacent to Precambrian basement (Kerr and de Vries, 1976) and at structural analysis of its basement rocks (Kerr and de Vries, 1977). This field campaign resulted in production of 1:250 000 scale geological maps of sedimentary cover rocks (Stewart and Kerr, 1984), however, the underlying Precambrian basement was represented only as one unsubdivided unit.

Subsequent geological mapping of the region north of 71°N by Frisch in 1986-1992, resulted in subdivision of the Precambrian basement (Frisch, 2011) into a typically orthopyroxene-bearing tonalitic to granitic unit of uncertain age (0{og); a metasedimentary unit of unknown age (0{ms) dominated by garnet ± sillimanite-bearing pelitic to semipelitic rocks with minor marble/calc-silicate (0{c), quartzite and iron-rich metasedimentary rocks (0{if; Frisch and Herd 2010); a mixed unit comprising layers of both orthogneiss and paragneiss (0{gm); and at least two suites of late- to post-tectonic syenitic granitoid rocks including 1.94 Ga two-pyroxene syenite ({sy) exposed at Cape Bird and 1708±5 Ma K-feldspar porphyritic granite ({Mg) with lesser associated anorthosite ({Ma) exposed around M'Clure Bay (Frisch and Hunt, 1993; Frisch, 2011). These units are interpreted to have experienced granulite-facies metamorphism at ca. 1.92 Ga (Frisch and Hunt, 1993), attaining conditions of 740-850°C and 6-8 kbar, locally up to 960°C and 8.7 kbar (Kitsul et al., 2000). They are estimated to have cooled from high-grade metamorphic conditions through ~600°C (titanite closure) at 1.873 Ga (western and central basement) and 1.845 Ga (eastern basement; Frisch and Hunt, 1993).

## Methodology

With the aim to update and improve understanding of the bedrock geology of Boothia Peninsula, six weeks of fieldwork took place in 2017, based from a low-impact tent camp. The temporary base camp was constructed 70 km north of the Hamlet of Taloyoak, NU, near a tributary of Sanagak (pronounced *huun-nee-guot*) Lake, one of the few locales to permit landing of a Twin Otter aircraft proximal to a fresh source of potable water. As typical for this region, weather negatively impacted coverage in 2017 with below-average temperatures, snow and ice fog. Regardless, 990 locations were mapped by foot traverse (Fig. 3), with the collection of some 1200 samples. Bedrock mapping was assisted by 10 students from Earth Sciences departments across Canada, two of whom are coauthors of this report and are undertaking MSc research. In addition, C-NGO Research Scientist Dr. Shunxin Zhang conducted targeted mapping and sampling of Paleozoic strata (Zhang, 2017) while surficial geologist Tommy Tremblay undertook surficial mapping and till sampling to expand understanding of ancient ice movement and dynamics north of Taloyoak (Tremblay et al., 2007; Tremblay, 2017).

Field operations in 2017 were supported by residents of Taloyoak, thirteen of whom worked at the camp for periods of 8-10 days as field, camp, and/or cook's assistant. A Letter of Agreement between Natural Resources Canada and the Hamlet of Taloyoak provided a means to hire and pay local personnel.

Prior to initiation of mapping, GEM addressed the lack of geophysical data for this region by investing in three high-resolution aeromagnetic surveys (Dumont, 2014; Coyle and Oneschuk, 2015; Tschirhart and Oneschuk, 2015; Coyle et al., 2016*a,b*). Airborne acquisition resulted in continuous coverage across the Boothia-Somerset corridor (Fig. 4). These data well reflect underlying units and structures, including that beneath till and Paleozoic strata (southwestern and northeastern Boothia Peninsula) and are effectively guiding bedrock mapping and geological interpretation throughout 2017 and 2018.

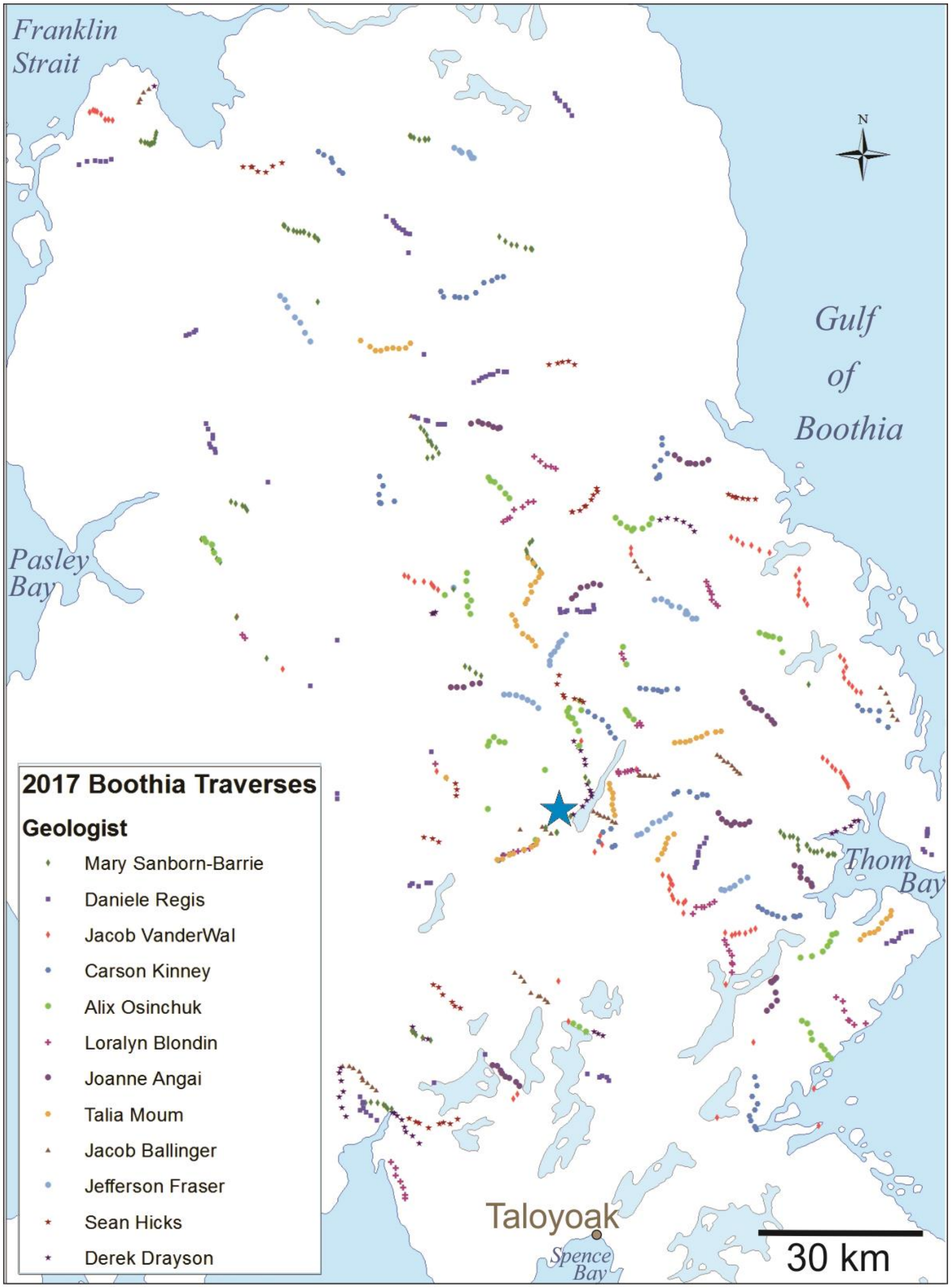

Figure 3. Locations on Boothia Peninsula at which ground observations, structural measurements, and photographs of exposed Precambrian rock were gathered in 2017. At most of these locations, bedrock samples were also collected. Blue star indicates the location of the temporary base camp near Sanagak Lake.

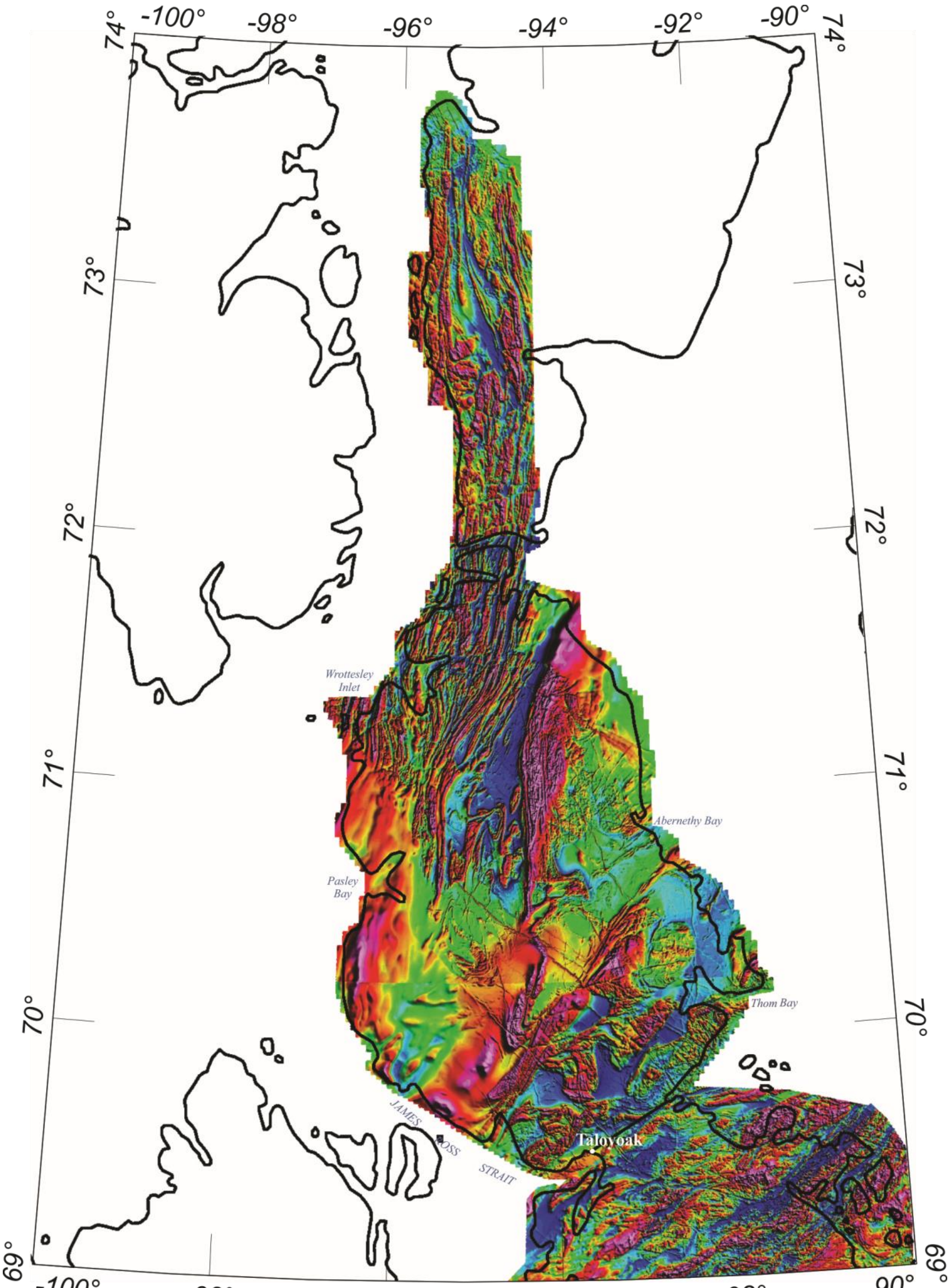

Figure 4. Total field aeromagnetic coverage for Boothia Peninsula and Somerset Island, Nunavut (Dumont, 2014; Coyle and Oneschuk, 2015; Coyle et al., 2016*a,b*).

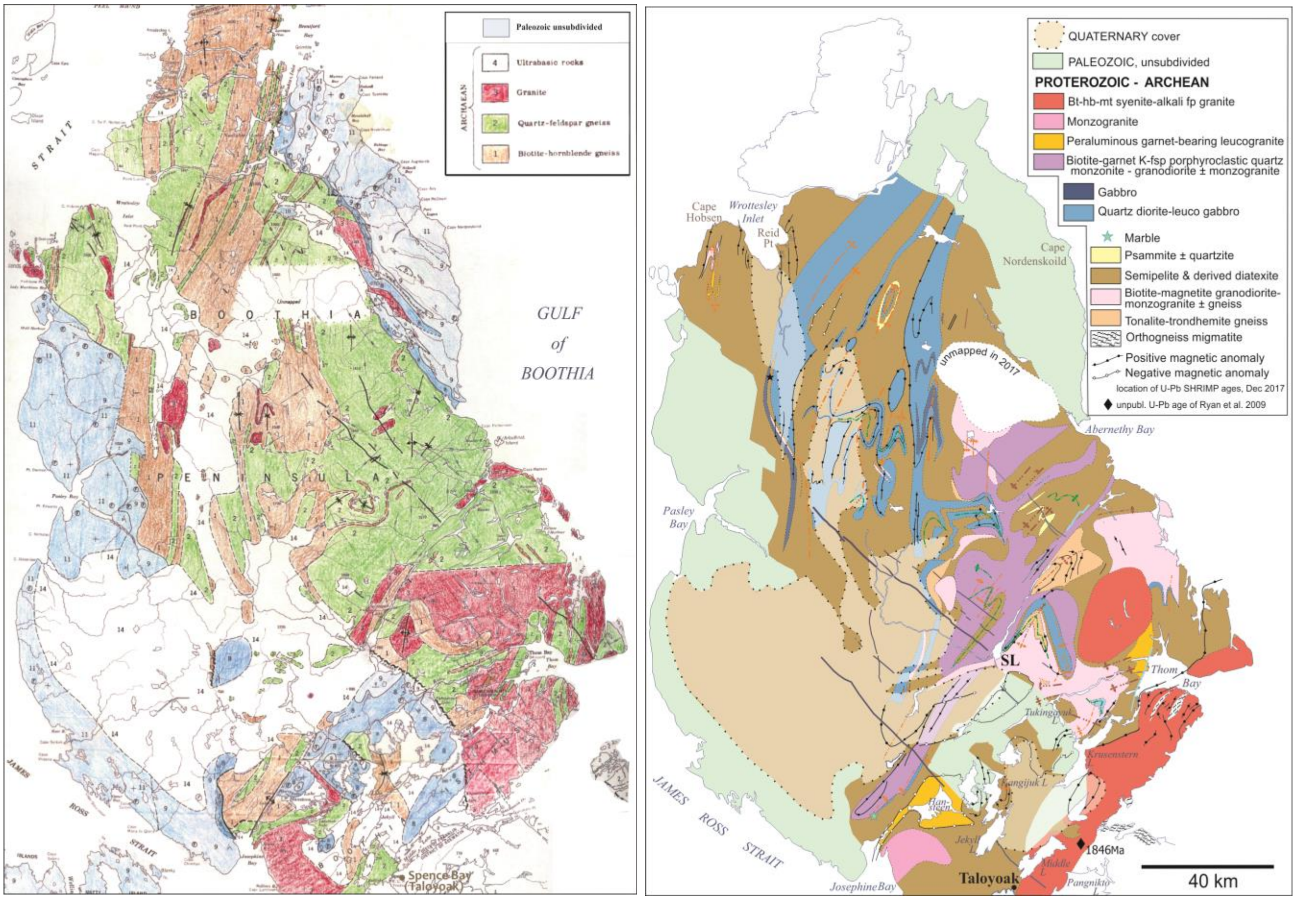

Figure 5. Geological map of Boothia Peninsula: ***a)*** hand-coloured geology map of Blackadar (1967) showing distribution of biotite-hornblende gneiss (brown), quartz-feldspar gneiss (green), granitic rocks (red), unsubdivided Paleozoic strata (light blue) and till (uncoloured); ***b)*** preliminary geological map based on 2017 mapping showing distinction between rocks of supracrustal origin (brown, yellow) and those of plutonic. Regions of till cover indicated by transparency. Diamond symbol 25 km NE of Taloyoak denotes location of unpublished U-Pb age of Ryan et al., 2009. **SL** = Sanagak Lake.

## Lithology

Based on field relationships, a relative chronology of major map units was determined, which will be tested using U-Pb zircon geochronology. These rock units are described below, from presumed oldest to youngest.

### *Orthogneiss*

Although previous mapping overwhelmingly interpreted Boothia Peninsula as a gneiss terrain (Blackadar, 1967; Fig. 5a), the distribution and extent of rocks exhibiting compositional layering due to metamorphic segregation is relatively minor based on exposures mapped in 2017. In the far southeast, ductilely deformed migmatitic rocks are exposed on coastal outcrops, and these may correlate with monzogranitic to granodioritic migmatitic gneiss (**OOdgm**) identified by Ryan et al. (2009) east and southeast of Taloyoak. Central to the mapped area, minor tonalite-trondjhemite gneiss (Fig. 6), structurally below K-feldspar porphyroclastic biotite-garnet quartz monzonite, is a candidate for basement rocks. East of Sanagak Lake, gneissic tonalite (Fig. 5*b*) may represent older substrate/basement, to widespread metasedimentary rocks (*described below*).

More felsic, pink weathering plutonic rocks are also layered, but these are invariably foliated granodioritic rocks (pale pink unit in Fig. 5*b*) cut by veins of medium- to coarse-grained ± pegmatitic monzogranite.

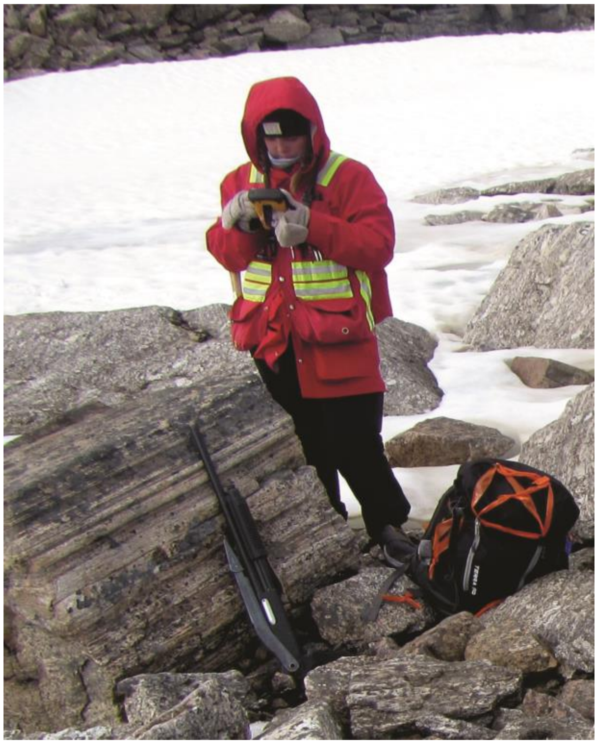

Figure 6. Block of straight compositionally layered tonalite-diorite orthogneiss, potential basement to Precambrian metasedimentary rocks exposed across much of Boothia Peninsula.

*Metasedimentary rocks and their migmatized equivalents*

Metasedimentary rocks and their migmatized equivalents are widespread across Boothia Peninsula (Fig. 5*b*) and typically coincide with quiet magnetic zones of low amplitude (Fig. 4). This unit is dominated by rusty-weathering semipelite with an assemblage of biotite-graphite-garnet ± sillimanite (Fig. 7*a*), locally with components of homogeneous diatexite and/or peraluminous garnet ± sillimanite ± cordierite leucogranite. Garnet-bearing psammite and quartzite (Fig. 7*b*) are lesser components that occur as ~6-60 cm wide layers with semipelite, while marble ± calcsilicate are least common. Two occurrences of marble – calc-silicate were mapped in 2017: the most extensive is located 45 km northwest of Taloyoak, west of Hansteen Lake (Fig. 5*b*), where a 200 m by 50 m highly deformed marble unit contains 10% dismembered layers or boudins of granite and cpx-garnetite (Fig. 8). In the northwest (west shore of Wrottesley Inlet, Fig. 5*b*), a 40 cm wide by 1 m long exposure of marble – calc-silicate and related float is associated with psammite. U-Pb dating of detrital zircon from metasedimentary samples collected from the northwest (M90), central (R87, R111), and southeast (M67) parts of Boothia Peninsula will be used to investigate the provenance of the samples, determine their maximum depositional age and constrain, where possible, a minimum depositional age by dating metamorphic rims on detrital zircon. Collectively, these U-Pb zircon analyses will establish the source and timing of deposition and allow determination of whether widespread metasedimentary rocks represent one or multiple clastic sequences.

Figure 7. Clastic metasedimentary rocks of Boothia Peninsula. ***a)*** dominant brown-weathering biotite-graphite-garnet ± sillimanite semipelite-pelite cut by white-weathering concordant garnet-bearing leucosome veins/sills (17SRB-M93); ***b)*** buff-weathering biotite-garnet psammite with minor semipelite (17SRB-M57).

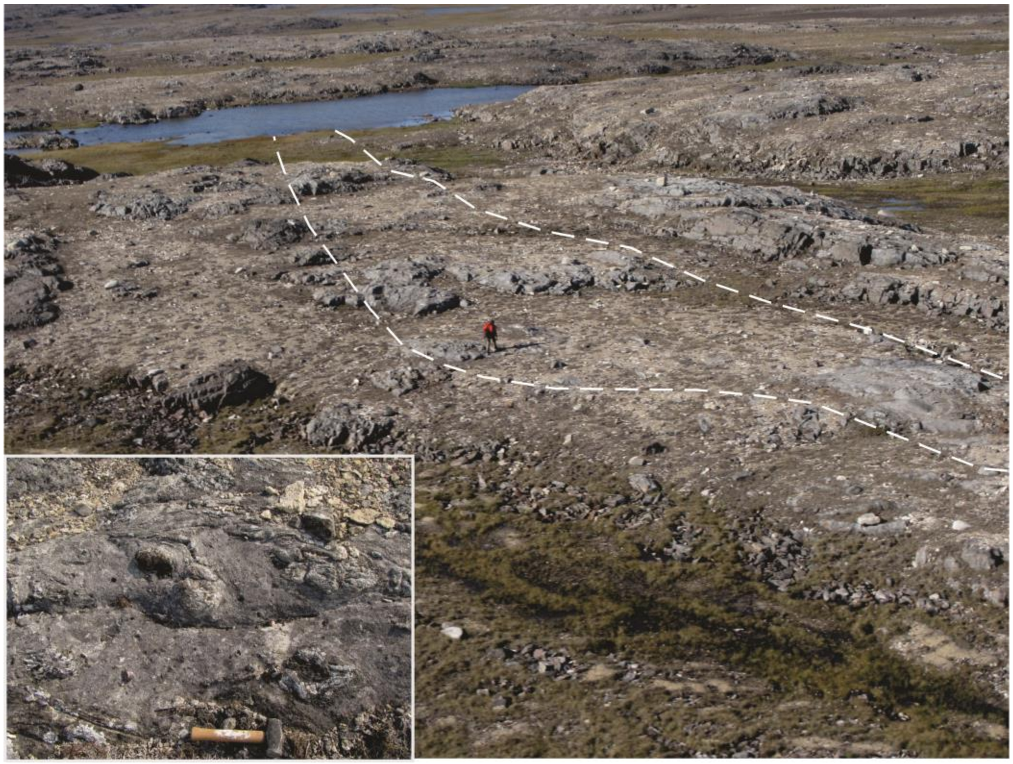

Figure 8. Aerial view of largest exposure (200m by 50 m) of marble-calc-silicate mapped in 2017 (17SRB-R105, 17SRB-M98), geologist for scale. Light-grey crumbly weathering of marble-dominated unit contrasts only slightly from adjacent medium grey weathering granitoid rocks. Inset shows detail of granoblastic marble containing distinct garnet-clinopyroxene inclusions. Hammer is 24 cm long.

### *Intermediate-Mafic Metaplutonic Rocks*

Metasedimentary rocks are cut by intermediate to mafic metaplutonic rocks dominated by diorite-quartz diorite ± gabbroic anorthosite (blue units, Fig. 5*b*). Gabbro and ultramafic plutonic rocks are present but rare. These intermediate-mafic rocks typically contain hornblende-clinopyroxene-orthopyroxenemagnetite±biotite Figs. 9*a*, *b*) and are expressed as linear, high amplitude magnetic anomalies, in strong contrast to the magnetically low metasedimentary rocks they cut (Fig. 4).

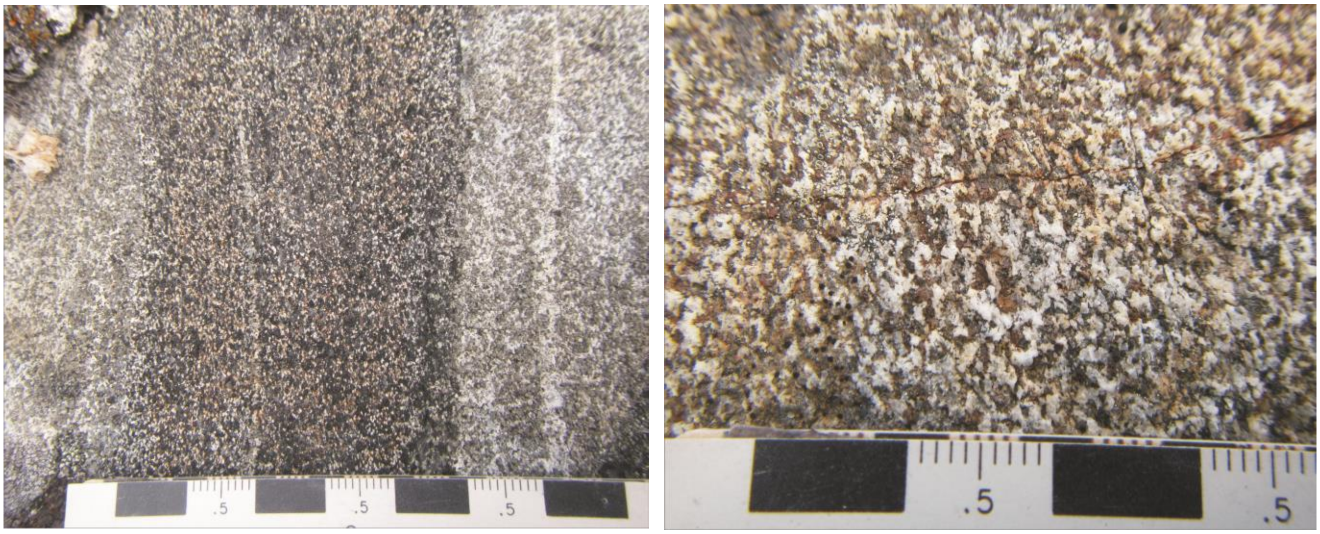

Figure 9. Intermediate to mafic metaplutonic rocks. ***a)*** gabbroic unit exposed south of Wrottesley Inlet with $S_2$ gneissosity (164/74°SW), defined by alternating dark green weathered hornblende-bearing layers and pale green weathered orthopyroxene-bearing layers (17SRB-M91). Note only weak prefered shape fabric typical of this suite. ***b)*** orthopyroxene-biotite-ilmenite quartz diorite showing weakly developed, preferred shape fabric oriented 175/56°WSW (17SRB-M51).

### *Pre- and/or syntectonic Intermediate-Felsic Granitoid Rocks*

Several generations of deformed felsic granitoid rocks were mapped that range from tonalitic to granodioritic. Of particular note is voluminous K-feldspar porphyritic biotite-garnet quartz monzonite-granodiorite (Fig. 5, 10*a*) that is typically moderately to strongly deformed and locally mylonitized. Where highly strained, this unit is distinctly and spectacularly porphyroclastic (Fig. 10*a*).

Widespread garnet-bearing leucogranite sills cut both metasedimentary rocks and the K-feldspar porphyroclastic biotite-garnet granitoid unit, and typically display lower strain than their hosts, suggesting relatively late-stage emplacement due to elevated geotherms.

### *Late- to Post-tectonic Syenitic Granitoid Rocks*

Weakly foliated to massive orthopyroxene alkali-feldspar granite and hornblende syenogranite (Fig. 10*b*) underlie southeastern Boothia Peninsula (Fig. 5*b*). These are suspected to, in part, correlate with a pluton dated at ca. 1846 Ma (J. Ryan, unpub. U-Pb data, 2009) located 25 km northeast of Taloyoak (diamond symbol in Fig. 5*b*). In select areas within the pluton, outcrop scale xenoliths of migmatized orthogneiss occurs that are lithologically equivalent to the coastal migmatized orthogneiss described earlier in this report.

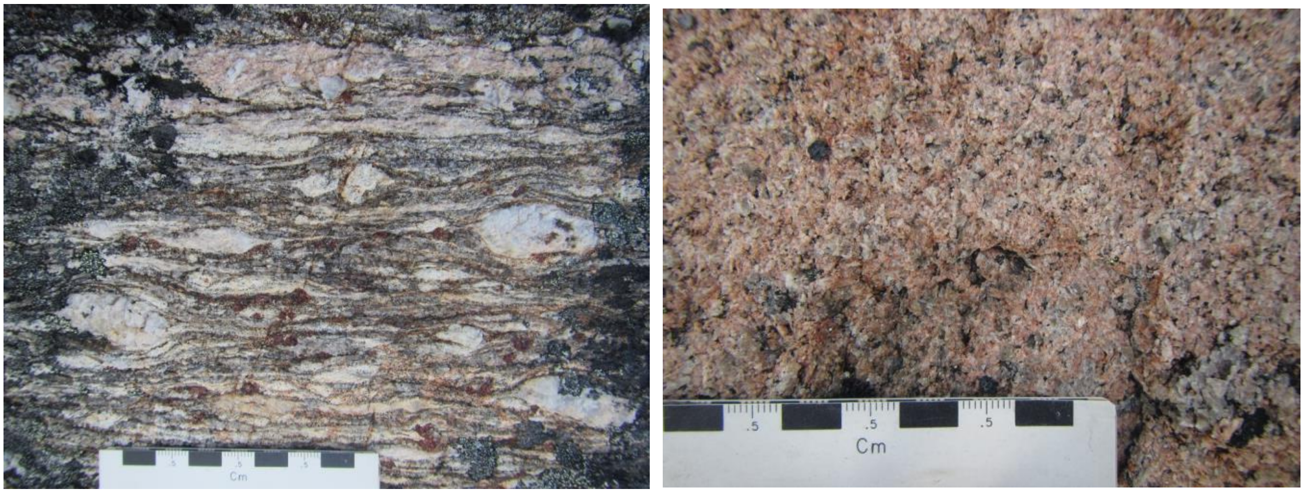

Figure 10. Intermediate-felsic granitoid rocks of Boothia Peninsula. ***a)*** tectonized K-feldspar porphyroclastic biotite-garnet quartz monzonite with mylonitic foliation oriented 223/67°NW (extension lineation 250/43°SW), due to localized ductile oblique-sinistral shearing along the regional-scale Sanagak Lake shear zone (17SRB-M8); ***b)*** post-tectonic massive, unfoliated syenogranite (17SRB-A15).

## Structural Geology

The deformational history of Boothia Peninsula is polyphase with many of the structural elements evident in the aeromagnetic data as discontinuities of the main trends, offsets in otherwise continuous anomalies, and curvilinear trends defining folds (Fig. 4). At least three penetrative deformation events are typically reflected in exposed Precambrian basement rocks, apart from the belt of late- to post-tectonic plutons exposed in the southeast. Since we are not confident of protolith ages for any units mapped, only the relative timing of the various deformational events is currently known, however, penetrative deformation of the region likely predates 1846 Ma, the age (unpubl. data reported in Ryan et al. 2009) of weakly foliated to massive syenogranite - alkali feldspar granite east of Taloyoak, NU (Fig. 5*b*).

In general, basement exposures across Boothia Peninsula display strongly developed, shallow to flat-lying fabrics (Fig. 11a). Rare, but widespread lower strain 'windows' (Fig. 11*b*) reveal the presence of folded $S_1$ fabrics indicating that the prominent shallow tectonic fabrics observed are $S_1$+$S_2$ trans-

Figure 11. Strongly developed, shallow-dipping fabrics developed in basement rocks of sedimentary origin across much of Boothia Peninsula. ***a)*** semipelite and associated cordierite-bearing leucosome (17SRB-M22) with strong tectonic foliation oriented 234/10°NW and with a well-developed oblique extensional lineation plunging 7° to the NE (024°). Hammer is 25 cm long. ***b)*** detail of **a)** showing closure of layering and $S_1$ foliation, highlighted by dashed white line, defining shallow-plunging, recumbent $F_2$ fold, such that the main shallow-dipping foliation is a $S_1$+$S_2$ transposition foliation axial planar to $F_2$.

position fabrics, axial planar to inclined and recumbent $F_2$ folds. Age constraints will help to establish whether these events are continuous and reflect progressive strain during one event, or the result of distinct, episodic events. $F_2$ folds and fabrics are refolded by upright $F_3$ folds, creating dome and basin (Type-2) and mushroom geometry (Type 3) interference patterns of 10-20 km scale, clearly evident in the aeromagnetic data (Fig. 3). These folds and fabrics are sinistrally deflected by a regional southwest-striking, moderately northwest-dipping shear zone that extends at least 160 km, transecting the southern part of the peninsula. This structure is marked by a number of linear lakes disposed along it including Sanagak Lake, such that it is here referred to as the Sanagak Lake shear zone.

## GEM-2 Supported Graduate Student Research on Boothia Peninsula

Two graduate student research projects are supported as part of this GEM activity. One project (A. Osinchuk, University of Alberta, Profs. T. Chacko and L. Heaman supervisors) is investigating the petrogenesis of the two major granitoid suites: the pre- to syn-tectonic K-feldspar porphyritic biotite-garnet quartz monzonite ± granodiorite suite (violet unit Fig. 5*b*; Fig. 10*a*) and the late- to post-tectonic syenitic suite (coral red unit Fig. 5*b*; Fig. 10*b*). Specifically, this investigation will:

1) determine and document the character of these granitoid suites and their field relationships;
2) identify the primary and metamorphic mineral assemblages and related textures through petrological analysis of representative samples;
3) identify minerals suitable to measure *in-situ* radiogenic isotope ratios (U-Pb, Lu-Hf) on the Laser Ablation Inductively Coupled Mass Spectrometer (LA-ICP-MS) at the University of Alberta, using U-Pb to determine primary crystallization ages and Lu-Hf to assess the ancestry and affinity (i.e., crustal versus mantle);
4) measure oxygen isotopic ratios from zircon with the Secondary Ion Mass Spectrometer (SIMS) in the Canadian Centre for Isotopic Microanalysis (CCIM) at the University of Alberta to further establish the genesis of these plutonic events. The analyses will be done on the same grain mounts as U-Pb geochronology done on the SHRIMP at the GSC.
5) obtain major, minor, and trace element geochemistry for representative samples from these suites and employ various classification schemes and discrimination diagrams to assess their tectonic affinity;

The above described granitoid petrogenesis research will not only reveal insights into the magmatic petrogenesis of Boothia Peninsula through time, but will also provide a foundation for structural research ongoing as part of the activity. MSc student, D. Drayson (University of Manitoba, Prof. A. Camacho supervisor) is investigating the extent, kinematics, timing and exhumation history of a regional-scale, southwest-striking, moderately northwest-dipping ductile shear zone. This structure represents a major deformation zone, designated here as the Sanagak Lake shear zone, which has yet to be documented or linked to, ascribed to assigned to a tectonic event. To provide insight into the kinematics, timing and regional tectonic significance of the Sanagak Lake shear zone, D. Drayson will:

1) document the extent and boundaries of the structure using aeromagnetic data and 2017 field observations of bedrock exposures;
2) examine micro-fabrics in thin section to determine the kinematic history and structural evolution during deformation and exhumation.
3) assess the metamorphic assemblages developed during different stages of deformation using mineral compositions, determined with Electron Probe Microanalysis (EPMA), to establish pressure and temperature conditions during shearing;
4) determine its timing of deformation and cooling (Ar-Ar) thereby allowing correlation with tectonic events known to have affected this part of the Columbia/Nuna supercontinent.

These MSc research projects provide excellent, field-based scientific training opportunities for young Canadians. Collectively, they will contribute insight into the magmato-tectonic processes that formed and reworked Precambrian basement rocks of Boothia Peninsula and, in turn, shed insight into the tectonic processes that affected the Canadian Arctic more than 1.8 billion years ago.

## Future Objectives

Data and observations from the 2017 fieldwork will lead to the compilation and publication of new 1:150 000-scale bedrock geology maps. Geochemical and samarium-neodymium isotope analyses, linked with new U-Pb geochronology and petrology data, will characterize the origin and metamorphic history of the different units recognized during the 2017 field season. The timing of sedimentary deposition, magmatic activity, and structural development will be determined so that their significance with respect to the Archean Rae, ca. 2.5-2.35 Ga Arrowsmith, ca. 2.0-1.9 Ga Thelon, ca. 1.86-1.78 Ga Trans-Hudson and/or ca. 460 Ma Caledonian orogenies can be assessed.

## Acknowledgements

We thank staff of the Polar Continental Shelf Program (PCSP) for logistical support throughout our 2017 field operations, without which field work would not be possible. Universal Helicopters of Newfoundland and Labrador provided expert rotary air support, in particular pilot Gerard Hartery and engineer Justin Burden. We very much appreciated Rosanda Bellaar-Spruyt's procurement and preparation of fresh food which sustained us daily in an isolated part of Canada. We thank the residents of Taloyoak for their welcoming hospitality and support in the field camp, and to Hamlet staff Senior Administrative Officer Greg Holitzki and Finance Controller Conrad Hickey who together facilitated our goal to integrate as many Taloyoak residents into our 2017 field operations as possible through employment. Special thanks to the other members of the 2017 mapping team: Joanne Angai, Jacob Ballinger, Loralyn Blondin, Jefferson Fraser, Sean Hicks, Carson Kinney, Talia Moum and Jacob VanderWal for their very capable assistance, hard work, and positive enthusiasm in all aspects of field work. Rob Berman reviewed this report and improved it through his suggested edits.

## References

Acosta-Góngora, P., Pehrsson, S., Martel, E., Lauzon, G., and Jamieson, D., 2017. South Rae Project: prelim-inary field observations (2015) and lake sediment analysis, Northwest Territories and Saskatchewan; Geological Survey of Canada, Scientific Presentation 67, 47 pp. doi:10.4095/302765

Berman, R.G., Nadeau, L., McMartin, I., McCurdy, M.W., Craven, J.A., Girard, É., Sanborn-Barrie, M., Carr, S., Pehrsson, S., Whalen, J.B., Davis, W.J., Roberts, B.J., and Grenier, A., 2015*a*. Report of activities for the Geology and Mineral Potential of the Chantrey-Thelon Area: GEM-2 Thelon tectonic zone; Geological Survey of Canada, Open File 7693, 14 pp. doi:10.4095/295644

Berman, R.G., Nadeau, L., Percival, J.A., Harris, J.R., Girard, E., Whalen, J.A., Davis, W.J., Kellett, D., Jefferson, C.W., Camacho, A., and Bethune, K., 2015*b*. Geo-Mapping Frontiers' Chantrey project: bedrock geology and multidisciplinary supporting data of a 550 kilometer transect across the Thelon tectonic zone, Queen Maud block, and adjacent Rae craton; Geological Survey of Canada, Open File 7698, 39 pp. (1 sheet), doi:10.4095/296202

Berman, R.G., Sanborn-Barrie, M., Nadeau, L., Brouillette, P., Camacho, A., Davis, W.J., McCurdy, M., McMartin, I., Weller, O., Chadwick, T., Liikane, D., and Ma, S., 2016. Report of activities for the GEM-2 project “Geology and Mineral Potential of the Chantrey-Thelon Area”: Thelon tectonic zone; Geological Survey of Canada, Open File 8129, 12 pp. doi:10.4095/299386

Berman, R.G., Davis, W.J., Sanborn-Barrie, M., Whalen, J., Taylor, B., McMartin, I., McCurdy, M., Mitchell, R., Ma, S., Coyle, M., Roberts B. and Craven J. In press. Report of 2017 activities: Thelon-Chantrey activity, Thelon Tectonic zone project; Geological Survey of Canada, Open File, 19 pp.

Blackadar, R.G., 1967. Precambrian geology of Boothia Peninsula, Somerset Island and Prince of Wales Island, District of Franklin. GSC Bulletin 151, 62 pp., 2 maps.

Brown, R.L., Dalziel, I.W.D. and Rust, B.R., 1969. The structure, metamorphism, and development of the Boothia Arch, Arctic Canada; Canadian Journal of Earth Sciences, 6, 525-543.

Coyle, M. and Oneschuk, D., 2015. First vertical derivative of the magnetic field, aeromagnetic survey of Somerset Island area, Nunavut; Geological Survey of Canada, Open Files 7669, 7670, 7672, 7673, 7674, 7675, and 7676.

Coyle, M., Boulanger, O., Tschirhart, V. and Kiss, F., 2016*a*. Residual total magnetic field, aeromagnetic survey of the northern Boothia Peninsula II, Nunavut, NTS 57-F and parts of 57-E, -F, -G, and 67-E,-H. Geological Survey of Canada, Open Files 8156, 8157, 8158, 8159, 8160, and 8161.

Coyle, M., Boulanger, O., Tschirhart, V. and Kiss, F., 2016*b*. First vertical derivative of the magnetic field, aeromagnetic survey of the northern Boothia Peninsula II, Nunavut, NTS 57-F and parts of 57-E,-F,-G and 67-E,-H. Geological Survey of Canada, Open Files 8162, 8163, 8164, 8165, 8166, and 8167.

Dineley, D.L. and Rust, B.R. 1968. Sedimentary and paleontological features of the Tertiary-Cretaceous rocks of Somerset Island, Arctic Canada. Canadian Journal of Earth Sciences, 5, 791-799.

Dixon, J. 1974. Revised stratigraphy of the Hunting Formation (Proterozoic), Somerset Island, Northwest Territories. Canadian Journal of Earth Sciences, 11, 635-642.

Dumont, R., 2014. Residual total magnetic field, aeromagnetic survey of northern Boothia Peninsula, Nunavut; Geological Survey of Canada, Open Files 7496, 7497, 7498, 7499, 7500, 7501, 7502, 7503, 7504, 7505.

Davis, W.J., Berman, R.G., and MacKinnon, A., 2013. U-Pb Geochronology of archival rock samples from the Queen Maud block, Thelon tectonic zone and Rae Craton, Kitikmeot Region, Nunavut, Canada; Geological Survey of Canada, Open File 7409, 40 pp. doi:10.4095/292663.

Davis, W.J., Berman, R.G., Nadeau, L., and Percival, J.A., 2014. U-Pb zircon geochronology of a transect across the Thelon Tectonic Zone, Queen Maud region, and adjacent Rae craton, Kitikmeot region, Nunavut, Canada; Geological Survey of Canada, Open File 7652, 41 pp. doi:10.4095/295177

Frisch, T., 2011. Geology, Precambrian geology of northern Boothia Peninsula and Somerset Island, Nunavut. Geological Survey of Canada, Open File 6051, 2 sheets; 1 CD-ROM, doi:10.4095/287896

Frisch, T. and Herd, R.K., 2010. Highly metamorphosed iron-formation on Arcedeckne Island, Boothia Peninsula, Arctic Canada, and the paragenesis of Harrisonite, $Ca(Fe,Mg)_6(SiO4)_2(PO_4)_2$. The Canadian Mineralogist, 48, 1005-1024.

Frisch, T. and Hunt, P A., 1993. Reconnaissance U-Pb geochronology of the crystalline core of the Boothia Uplift, District of Franklin, Northwest Territories. in, Radiogenic age and isotopic studies: report 7; Geological Survey of Canada; Geological Survey of Canada, Paper no. 93-2, 1993 p. 3-22, doi:10.4095/193329

Giguère, J.F., 1968. Element distribution in coexisting pyroxenes from granulite rocks of southeast Stanwell-Fletcher Lake area, Somerset Island, District of Franklin, N.W.T. University of Ottawa, Master of Science, 126 pp.

Jones, B. and Dixon, O.A., 1975. The Leopold Formation: An Upper Silurian Intertidal/Supratidal Carbonate Succession on Northeastern Somerset Island, Arctic Canada. Canadian Journal of Earth Sciences, 12, 395-411.

Kerr, J.W., 1976. Geological Investigations of Somerset Island and Boothia Peninsula (Operation Boothia: 57C,F,G; 58A to F) District of Franklin. Geological Survey off Canada Paper 76-1A. 491-492, doi:10.4095/104252.

Kerr, J.W., 1977. Cornwallis Fold Belt and the mechanism of basement uplift. Canadian Journal of Earth Sciences 14, 1374-1401.

Kerr, J.W. and Christie, R.L., 1965. Tectonic history of Boothia uplift and Cornwallis fold belt, Arctic Canada. Bulletin of American Association of Petroleum Geologists, 49, 905-926.

Kerr, J.W. and de Vries, C.D.S., 1977. Structural Geology of Somerset Island and Boothia Peninsula, District of Franklin. Report of Activities, Part A; Geological Survey of Canada, 107-111.

Kitsul, V.I., Glebovitsky, V.A., Vapnik, Y.A and Frisch, T., 2000. Gneisses from the granulite terrane of the central Boothia Uplift, Arctic Canada. The Canadian Mineralogist 38, 443-454.

Percival, J., A., Martel, E., Pehrsson, S. J., Acosta-Gongora, P., Regis, D., Theissen, E., Jamieson, D., Neil, B., and Knox, B., 2016. Report of 2016 bedrock activities for the geologic and metallogenic framework of the south Rae Craton, southeast NWT: GEM-2 South Rae Quaternary and Bedrock Project. Geological Survey of Canada, Open File 8142, 17 pp. doi:10.4095/299469

Regis, D., Martel, E., Davis, W. J., Pehrsson, S. J., 2017. U-Pb zircon geochronology of metaplutonic rocks across the southern Rae Province, Northwest Territories; Geological Survey of Canada, Open File 8254, 37 pages, doi:10.4095/302772

Ryan, J.J., Nadeau, L., Tremblay, T., Davis, W.J., Berman, R. G., James, D.T. and Brouillette, P., 2009. Geology and analytical results of the Boothia mainland area, Kitikmeot region, NU; Geological Survey of Canada unpublished Poster Presentation at Mineral Exploration Roundup, Vancouver, BC, January 27-29, 2009.

Sanborn-Barrie, M., Ford, A., Hillary, E., Tschirhart, V.L., Tremblay, T., and Maharaj, J., 2016*a*. 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

Sanborn-Barrie, M., Hillary, E.M., Tremblay, T., Ford, A., Tschirhart,V.L., and Maharaj, J., 2016*b*. Commitment of the Geo-mapping for Energy and Minerals program to community engagement in Nunavut: the Taloyoak Geoscience Field School initiative; *in* Summary of Activities 2016, Canada-Nunavut Geoscience Office, p. 131–140.

Stewart, W. D. and Kerr, J.W., 1984. Geology of Somerset Island North, District of Franklin. Geological Survey of Canada, Map 1595A.

Tersmette, D.B., 2012. Geology, geochronology, thermobarometry, and tectonic evolution of the Queen Maud block, Churchill craton, Nunavut, Canada. University of Alberta, Master of Science, 170 pp.

Thériault, R.J., Henderson, J.B., and Roscoe, S.M., 1994. Nd isotopic evidence for early to mid-Archean crust from high grade gneisses in the Queen Maud Block and south of the McDonald Fault, western Churchill Province, Northwest Territories; in Radiogenic Age and Isotopic Studies; Report 8; Geological Survey of Canada, Current Research, 37-42.

Tschirhart, V. and Oneschuk, D., 2015. Aeromagnetic interpretation products, Somerset Island, Nunavut, parts of NTS 58B/3, 4, 5, 6, 11, 12, 13, 14, parts of NTS 58C/3, 4, 5, 6, 11, 12, 13, and parts of NTS 57G/13, 14; Geological Survey of Canada, Open File 7805, 4 sheets, doi:10.4095/296720

Tremblay, T., Ryan, J. J. and James, D. T., 2007. Ice-flow studies in Boothia mainland (NTS 57A and 57B), Kitikmeot region, Nunavut; Geological Survey of Canada, Open File 5554, 16 pp. doi:10.4095/224165

Tremblay, T., 2017. Advances in the surficial geology study of Boothia Peninsula, central Nunavut; in Summary of Activities 2017, Canada - Nunavut Geoscience Office, p. 21–36.

Zhang, S., 2017. Report of field activities for Ordovician stratigraphy, Boothia Peninsula, Nunavut – part of the GEM-2 Integrated Geoscience of the Northwest Passage: Boothia Peninsula–Somerset Island Activity; in Summary of Activities 2017, Canada - Nunavut Geoscience Office, 13–20.