DESCRIPTIVE NOTES

INTRODUCTION

This contribution is part of the Melville Peninsula Project (MPP) under the Natural Resources Canada's Geo-mapping for Energy and Minerals (GEM) program, a collaborative effort between the Geological Survey of Canada (GSC) and the Canada-Nunavut Geoscience Office (C-NGO). It focuses on the geology of the Prince Albert Group (PAG) volcanosedimentary sequence as it outcrops in the Prince Albert Hills of central western Melville Peninsula.

Geological mapping of parts of the northern Foister Lake (NTS 47-B/2) and southern Mackar Inlet (NTS 47-B/7) was initiated during the summer of 2009 by revisiting some of Frisch (1982) key outcrops of ultramafic rocks and geochronological dating sites. This was followed by systematic regional mapping (Machado et al., 2011) in conjunction to thematic studies during the summer of 2010 (Richan et al., 2011a; Rigg et al., 2011). This new geological update of the Prince Albert Hills greatly benefits from Frisch's pioneering mapping at 1:125 000 scale conducted between 1972 and 1974 and reported in Frisch (1982). The bulk of it original field data is being integrated into the new GIS-based geodatabase underpinning the current map.

GEOLOGICAL FRAMEWORK

The Prince Albert Hills are located in the north-central Rae Craton of the western Churchill Province. They are underlain by volcanosedimentary rocks belonging to the Prince Albert Group (sensu lato), singled-out and referred to hereafter as the Prince Albert Greenstone Belt (PAGB) dated at 2.9 Ga (Corrigan et al., 2011; Wodicka et al., 2011). It comprises highly metamorphosed and deformed volcanic and sedimentary rocks. The metavolcanic rocks are mainly basaltic in composition, with rhyolite and dacite being locally abundant. Ultramafic rocks including komatiitic lavas and intrusions are also locally abundant. In addition to magnetite-quartz banded iron-formation (BIF), pelitic schist and gneiss are major components of the volcano-sedimentary succession. Almost all iron deposits in the area are Algoma Type banded iron-formation and were characterized by tight compact folding within the supracrustal succession (Wilson and Underhill, 1971).

DETAILED GEOLOGY

Previous geological mapping provided a basis to establish the general geological framework and the major lithological components of the southern part of the PAGB. Our more detailed observations of field relationships and lithological associations led to the subdivision of the PAGB into three supracrustal packages informally referred to as the *snake*, *Borealis* and *Triangle Lake* supracrustal packages (Machado et al., 2011).

The *snake supracrustal package*, interpreted to be located at the base of the PAGB succession, is composed predominantly of mafic and intermediate metavolcanic rocks. The metavolcanics (unit Asmv) vary from dark-green to black on fresh and weathered surfaces. The Asmv rocks commonly occur as amphibolite schist and/or layered amphibolite with poorly preserved relict volcanic features, however massive and pillowed bands are more easily recognized in low strain zones. Although generally highly stretched, pillow morphology is consistent with an east younging facing stratigraphic direction. Mafic metavolcanics are intercalated locally with thin units of foliated felsic to intermediate metavolcaniclastic rocks, and with pelite and/or psammite (unit Astvc) also characterized by pervasive carbonate alteration.

The spatial association between mafic-intermediate metavolcanic rocks (unit Asmv), and extrusive and/or intrusive meta-ultramafic rocks (units Asui and Asuv) is a key feature of this supracrustal package. The latter are distinguished by their brownish, rusty-ochre, brown or whitish weathering colours and pervasive carbonate alteration. The meta-ultramafic rocks (unit Asuv) of the southwestern part of the map area comprise undifferentiated and differentiated komatiite flows, the latter consisting of an upper spinifex zone and a lower massive olivine cumulate zone (Richan et al., 2011a; Richan et al., 2011b). The bedding is overturned with younging direction towards the east-northeast. A well-bedded ultramafic metavolcaniclastic unit (Asuvc) including altered tuff and lapilli tuff, with chlorite, altered plagioclase and carbonate minerals, occurs within the section. Other meta-ultramafic bodies of unit Asui sporadically occur within unit Asmv and are referred as intrusive ultramafic bodies. One of these, located north of the Adamson River, is composed of a fine-grained peridotite with nickel sulphide mineralisation occurring at the contact between mafic metavolcanics and gabbro (Houlé et al., 2010). In addition, a sill-like body crops out for over three kilometres and share very similar textures and mineralogy with other small ultramafic lenses occurring within the mafic metavolcanic rocks. Many of these are pervasively altered to talc and carbonate assemblages.

The *Borealis supracrustal package* comprises a variety of intermediate to felsic metavolcanic rocks restricted to the southern part of the map area. These include fine-grained massive metavolcanic rocks of unit Asfv, which typically exhibit light- to dark-grey or light-green colours on fresh surfaces, and white, light-green or light-grey weathered surfaces. The ubiquitous and widespread occurrence of quartz phenocrysts, giving a quartz-eyes-texture, constitutes their most diagnostic field feature. Felsic to intermediate metavolcaniclastic rocks with quartz phenocrysts (unit Asfvc) also occur in this package. Noticeable among them is a tuff horizon exhibiting nicely preserved primary sedimentary structures such as cross-bedding, graded-bedding and soft-sediment slump structures, giving a stratigraphic younging direction towards the northeast.

The *Triangle Lake supracrustal package* is dominated by mafic to intermediate metavolcanic rocks with lesser oxide/silicate-facies banded iron-formation, felsic to intermediate metavolcaniclastic and clastic metasedimentary rocks. These mafic to intermediate metavolcanic rocks (unit ATLmv) resemble those of the *snake supracrustal package*, but differ by their close spatial association with iron-formation. The rocks are variably deformed and recrystallized, ranging from massive to amphibolite schist with no preserved primary volcanic texture. Map unit ATLvc, also characteristic of this package is singled-out by the intimate intercalation at metre- to decametre-scale of metavolcanics and metasedimentary rocks invariably spatially associated with iron-formation. The intensity of metamorphism and deformation makes the protolith determination difficult. This unit appears however to be dominated by metavolcaniclastic rocks. Their weathered and fresh surfaces colours range from white to medium-grey, and light- to dark-grey respectively. They are chiefly composed of quartz and feldspars, with metamorphic garnet, staurolite and micas in variable proportions. Metavolcaniclastic rocks of unit ATLvc are interbedded with metasediments of unit ATLsp.

Rocks of unit ATLsp occur as concordant screens commonly too thin to be reported at map-scale. The unit consists mainly of pelitic and subordinate psammitic paragneisses occurring in a ~ 3 to 1 ratio. They are derived from mudstone, wacke, and impure sandstone. No primary sedimentary structure is recognized. These rocks range in colour from pale- to dark-grey or black depending of the biotite content. Weathering of micas and disseminated sulphide grains give a rusty brown weathering colour. Rocks are generally fine- to medium-grained, with variable amounts of biotite, muscovite, feldspars, and quartz, and in places with one or more of garnet, staurolite, sillimanite, and cordierite. The unit includes two thin beds of conglomerate in spatial association with iron-formation. Pebble composition, size and shape vary considerably, but most are ovoid and include quartzite and granitoid fragments; clasts of iron-formation have been reported by Frisch (1982).

Distinguishing between metavolcaniclastic (unit ATLvc) and metasedimentary (unit ATLsp) protoliths is commonly challenging as relict primary attributes are extensively obliterated after regional metamorphism. Metasedimentary rocks are however usually distinguished by their larger mica content. In addition, metavolcaniclastic rocks are generally more massive and homogeneous, and do not exhibit the rusty weathering common to the metasediments.

Noteworthy is the local occurrence of metavolcanic flows within metavolcaniclastic and metasedimentary rocks; flows are generally massive, darker than the metavolcaniclastic rocks and do not exhibit the strong foliation and/or bedding that characterize the other rock types within the package. They show a wide compositional spectrum from felsic to mafic and occur as concordant sheets. Although rare, columnar jointing occurs locally at flow contacts giving an eastern younging direction to the sequence. The likelihood that some sheets interpreted as flows be derived from sills cannot be ruled out.

Banded iron-formations (unit ATLsif) are relatively abundant within the *Triangle Lake supracrustal package*. In general, banded iron-formation weathered surfaces are steely black to reddish coloured where hematite is abundant. They typically exhibit thin laminas of alternating magnetite and quartz-chert-amphibole. The thickness of the banded iron-formation is highly variable in the area ranging from a few up to more than 300 hundreds metres. It is inferred from field observations and geophysical signature that they mark at least two different stratigraphic horizons. One of them forms a north-northeasterly striking stratigraphic marker continuous for over ten kilometres. The second horizon is thinner and occurs discontinuously over the same distance; it is a few hundreds metres apart structurally apart from the first horizon.

Bright white medium-grained quartzite (unit ATLsq) occurs at one locality in contact with an iron-formation. It comprises accessory muscovite defining the foliation. An ultramafic dyke (unit ATLul) cuts the package in the northern part of the study area; it exhibits similar mineralogy and textures and resembles meta-ultramafic rocks of the *snake supracrustal package*.

The PAGB is hosted and intruded by several contrasting granitoid lithologies distinguished as map units Agn, Ato, and Agr. Unit Agn outcrops in the eastern part of the map area. It consists of well-foliated to gneissic biotite-hornblende granite to granodiorite varying in colours from white to pink on both weathered and fresh surfaces. Tonalitic rocks of unit Ato are greyish, weakly foliated, and mesocratic with biotite and subordinate hornblende. Rocks of the Agr unit comprises pinkish, massive to weakly foliated biotite-amphibole granite to granodiorite with numerous Prince Albert Group xenoliths. This unit has yielded a minimum age ca. 2203 Ma (Frisch, 1982) near Triangle Lake where it intrudes the *Triangle Lake supracrustal package*. Rocks of the Prince Albert Group are also intruded by small massive to foliated gabbro (unit Aga) and diorite (unit Adi) bodies, and cross-cut by brownish amphibolite dykes (unit Amd).

The youngest metasedimentary sequence in the study area belongs to the Foister Lake Group; it includes schist, conglomerate, marble, iron-formation, and arkose (Frisch, 1982) and sits uncomformably over the PAGB. Foister Lake sediments have experienced folding and metamorphic fabric overprinting prior to the intrusion of fresh, massive, magnetic, locally olivine-bearing dykes of the Mackenzie and Franklin swarms.

STRUCTURAL GEOLOGY

The PAGB has undergone at least two phases of regional deformation under medium grade metamorphic conditions with the oldest event dating back to the Archean, prior to being transected by a major northwest striking subvertical brittle fault network giving way to deep trenches in the current topography. Several of these late faults show apparent left-lateral displacement of Prince Albert Group rocks limiting along strike correlation; the displacement related to these brittle faults may reach up to 500 metres.

The most prominent phase of ductile deformation giving the dominant fabric in the area is characterized by a strong northeast-southwest striking sub-vertical amphibolite-grade foliation. The less prominent fabric shows up as an east-west striking foliation. Despite the fact that those two fabrics occurred within the entire map area, the northeast-southwest fabric appears to be more prominent within the *Triangle Lake supracrustal package* and has a strong influence on the map pattern. In contrast, the east-west foliation is better developed in the southwest portion of the *snake supracrustal package* in spite of the fact that the northeast-southwest fabric remains the dominant fabric of the area. In addition, partitioning of the deformation is noted across the PAGB along a strike-parallel boundary subdividing the belt into a western domain including the *snake and Borealis* supracrustal packages, and an eastern domain comprising the *Triangle Lake supracrustal package*. The full structural and stratigraphic significance of this boundary remains to be assessed; this boundary may be tectonically significant as it appears to limit the extent of the *Triangle Lake supracrustal package*.

MINERAL POTENTIAL

Mineral exploration in the area dated back to the 1960's. It has been mostly geared towards iron ore mineralization, but other commodities including base metals, gold, and diamonds have been explored over the years. As per the summer 2010, the Nunavut geoscience database reports no significant assays result from the area, except for iron reserve that has been estimated at 1.22 x 10^9 tonnes of magnetite ore (Wilson and Underhill, 1971).

Considering the overall geological context of the PAGB, the potential to find new mineralization is high as shown by the discovery of a new nickel showing as part of the present geological mapping effort. Indeed, the occurrence of ultramafic rocks is highly prospective to host nickel, copper, and platinum-group element mineralization as demonstrated by the discovery of the Adamson River Nickel showing (Houlé et al. 2010) where sulphides mineralization grades up to 8.0% Ni at the contact between a metaperidotite and mafic metavolcanic / metagabbroic rocks. In addition, a grab sample from a gossan hosted in metavolcanic rocks collected in 2010 returned up to 85 g/t silver, >1% zinc, 0.1% copper, 0.1% lead, and 0.09 g/t gold. This highlights the prospectivity for volcanogenic massive sulphides (VMS) mineralization in the PAGB. Other types of mineralization should not be disregarded, namely gold associated with iron-formation.

Abstract

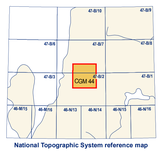
Supracrustal rocks of western Melville Peninsula form the Prince Albert Greenstone Belt, which is comprised of rocks dated 2.9 Ga and attributed to the Prince Albert Group, a distinctive lithostratigraphic unit of the Rae Craton.

The belt is subdivided into three supracrustal packages based on field relationships and lithological associations. The *snake supracrustal package*, which is comprised mainly of mafic to intermediate subaqueous metavolcanic and metavolcaniclastic rocks with lesser meta-ultramafic flows/sills and metavolcaniclastic rocks, outcrops at the base of the succession. The *Borealis supracrustal package* consists of felsic to intermediate, brecciated to massive metavolcanic rocks all containing quartz phenocrysts. The *Triangle Lake supracrustal package* is dominated by mafic to intermediate metavolcanic rocks intercalated with banded iron-formations and subordinate felsic to intermediate metavolcaniclastic rocks. During mapping, the discovery of a nickel showing in a meta-ultramafic intrusion and of a silver-zinc gossan within metavolcaniclastic rocks highlights the mineral potential of the Prince Albert Greenstone Belt.

Résumé

Les roches supracrustales, âgée de 2,9 Ga, du Groupe de Prince Albert, dans la partie ouest de la péninsule de Melville forment la ceinture de roches vertes de Prince Albert, une unité lithostratigraphique distincte du craton de Rae.

La ceinture est subdivisée en trois ensembles supracrustaux, sur la base des relations de terrain et des associations lithologiques. L'*ensemble supracrustal de snake* est principalement composé de coulées sous-marines et de roches métavolcaniclastiques, de composition mafique à intermédiaire, localisé à la base de la succession. Cet ensemble comprend également des coulées, des roches volcaniclastiques et des sills de composition ultramafique. L'*ensemble supracrustal Borealis* est composé de roches métavolcaniques massives, brèchiques et volcaniclastiques de composition felsique à intermédiaire contenant des phénocristaux de quartz. L'ensemble supracrustal de Triangle Lake est principalement composé de roches métavolcaniques mafique à intermédiaire interlitées avec des formations de fer rubanées associées a des roches métavolcaniclastiques felsique à intermédiaire. La découverte, lors de la cartographie, d'un indice de nickel associé à une intrusion méta-ultramafique et d'un chapeau de fer riche en argent-zinc dans des roches métavolcaniclastiques démontrent le potentiel métallifère de la Ceinture de roches vertes de Prince Albert.



National Topographic System reference map

Cover illustration:
Prince Albert Hills overlooking Committee Bay, Nunavut. Photograph by G. Machado. 2011-051.

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CANADIAN GEOSCIENCE MAP 44
(preliminary version)
GEOLOGY
SOUTHERN PART OF PRINCE ALBERT GREENSTONE BELT, PRINCE ALBERT HILLS
Melville Peninsula, Nunavut
1:25 000

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Geology by G. Machado, M.G. Houlé, L. Richan, J. Rigg, and D. Corrigan, 2010; D. Corrigan and M.G. Houlé, 2009; T. Frisch, 1972-1974; N. Gould, 1974; Borealis Exploration Limited, 1969–1970

Geological compilation by G. Machado and M.G. Houlé

Cartography by C. Gilbert, P. Brouillette, R. Boivin, and N. Côté

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Map projection Universal Transverse Mercator, zone 16. North America Datum 1983

Base map at the scale of 1: 50 000 from Natural Resources Canada, with modifications.
Elevations in metres above mean sea level

Some geographical names subject to revision

Proximity of the North Magnetic Pole causes the magnetic compass to be erratic in this area.
Magnetic declination 2011, 25° 42' W, decreasing 25.4' annually.

The Geological Survey of Canada welcomes corrections or additional information from users.

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CANADIAN GEOSCIENCE MAP 44
(preliminary version)
GEOLOGY
SOUTHERN PART OF PRINCE ALBERT GREENSTONE BELT, PRINCE ALBERT HILLS
Melville Peninsula, Nunavut

LEGEND

CENOZOIC
- Q — Quaternary sediments of fluvial, glacial or marine origin.

PROTEROZOIC
- Pd — Diabase and olivine diabase dyke.
- PFL — Foster Lake Formation: comprises meta-arkose, metasedimentary phyllite and schist, metaconglomerate, and marble.

ARCHEAN
- Amd — Amphibolite metadyke.
- Adi — Metadiorite.
- Aga — Metagabbro, locally foliated.
- Agr — Massive to poorly foliated metagranite and metagranodiorite, locally including xenoliths of the Prince Albert Group.
- Agn — Well foliated to gneissic metagranodiorite and metagranite.
- Ato — Poorly foliated metatonalite, locally including xenoliths of the Prince Albert Group.

PRINCE ALBERT GROUP (ASmv–ATLui)
Triangle Lake supracrustal package
- ATLui — Talc-carbonate meta-ultramafic intrusive rocks.
- ATLsq — Muscovite-bearing quartzite.
- ATLsif — Silicate-magnetite meta-iron formation with minor hematite-silicate ironstone.
- ATLsp — Pelite and mica-rich psammite with one or more of garnet, cordierite and sillimanite.
- ATLvc — Composite unit comprising up to 10 meters thick bands of metamorphosed intermediate to felsic volcaniclastic rocks, subordinate metre-thick screens of metasediments (unit ATLsp) and less commonly of mafic to felsic volcanic flows.
- ATLmv — Massive to foliated, mafic to intermediate metavolcanic rocks.

Borealis supracrustal package
- Asfv — Massive, brecciated to foliated, felsic to intermediate metavolcanic rocks with quartz phenocrysts.
- Asfvc — Felsic to intermediate metavolcaniclastic rocks containing biotite, muscovite and, locally, quartz phenocrysts.

snake supracrustal package
- Asfvc — Felsic to intermediate metavolcaniclastic rocks with carbonate alteration, locally interbedded with psammite and/or pelite.
- Asuvc — Talc-carbonate-serpentine meta-ultramafic volcaniclastic rocks.
- Asuv — Talc-carbonate-serpentine meta-ultramafic extrusive/intrusive rocks, locally displaying cumulate and spinifex textures.
- Asui — Talc-carbonate-serpentine meta-ultramafic intrusive rocks, locally displaying cumulate textures.
- Asmv — Pillowed, massive to foliated, mafic to intermediate metavolcanic rocks.

- Geological contact (approximate)
- Limit of mapping
- Fault
- Linear discontinuity
  - inferred discontinuity between the western *Borealis* and *snake*, and the eastern *Triangular Lake* supracrustal packages
- Axial trace (approximate)
  - synform, synform
- Bedrock outcrop examined for this project (2009–2010)
- Bedrock outcrop compiled from previous projects (1972–1974)
- Gossan
- Mineral showings
  - Ag = silver
  - Zn = zinc
  - Ni = nickel
- Isotopic age (U-Pb)
  - (1) Frisch (1982)
  - (2) Wodicka et al. (2011)
- Bedding
  - inclined
- Foliation
  - inclined, vertical
- Gneissosity
  - inclined
- shear zone
- mineral lineation
- fold hinge, with plunge
- glacial striae, direction unknown

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Four trim marks around perimeter of map sheet. Trim map sheet first, then fold at folding marks.

Cover and additional panels are 17cm wide when folded.