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Introduction

Bedrock exposures on Cumberland Peninsula, eastern Baffin Island, Nunavut have long been thought to be the eastern extension of central Baffin Island's Paleoproterozoic Piling Group (Jackson and Taylor 1972; St-Onge at el., 2006), a continental margin succession deposited on Meso- to Neo-archean Rae basement between ca. 2.16 – 1.9 Ga (Fig. 1). Discovery of gold-bearing strata in the Piling Group, mainly associated with the ca. 1.93 Ga rift-related Bravo Lake formation and associated chemical metasedimentary rocks by Commander Resources Limited (http://www.commanderresources.com/s/BaffinIsland.asp), highlighted a potential for gold mineralization in presumed correlative lithological units on Cumberland Peninsula. Recent mapping under the auspices of Natural Resources Canada's GeoMapping for Energy and Minerals (GEM) program, has resulted in a vastly improved understanding of Cumberland Peninsula's lithological associations, crustal architecture and mineral potential. This new geoscience knowledge has been used to update the regional metallogenic framework and will ultimately lead to more effective mineral exploration strategies for this under-explored frontier region.

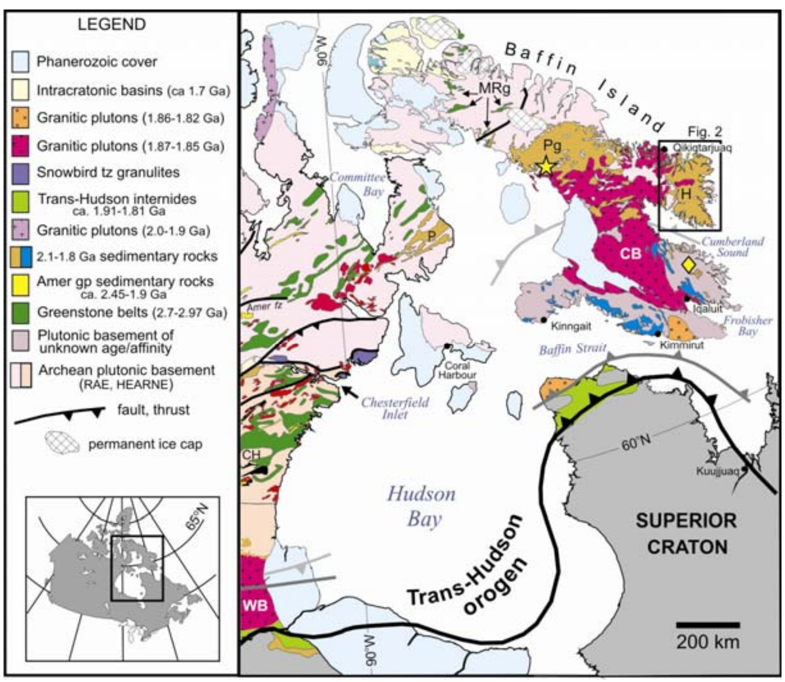

Figure 1. Regional geology of NE Laurentia (modified from Berman et al., 2005), as depicted on published maps prior to the 2009 GEM Cumberland Peninsula project (black rectangle) showing Paleoproterozoic metasedimentary rocks (brown) of the Hoare Bay Group (H), central Baffin's Piling Group (Pg) and Melville Peninsula's Penryn Group (P). Focus of ongoing gold exploration in the Piling Group indicated by yellow star, focus of ongoing diamond exploration on Hall Peninsula indicated by yellow diamond.

This Open File release presents lithogeochemical and assay data for 89 gossanous rocks sampled from surface exposures across Cumberland Peninsula. The analyses were performed at Activation Laboratories (Actlab) Limited's Ancaster, Ontario laboratory using fire assay as well as acid digestion and instrumental analysis (see Appendix I). The data are compiled in the accompanying excel file ***OF6916_CP_assays.xls*** on two worksheets. Worksheet 1 lists the samples, analytical results, location information (latitude & longitude in decimal degrees), field rock name and related field notes, and includes internet addresses for Actlab procedures summarized in Appendix I. Worksheet 2 presents the quality assurance/quality control (QA/QC) data for the analyses.

Geology of Cumberland Peninsula

On the basis of bedrock mapping conducted as part of the GEM Cumberland Peninsula Integrated Geoscience project in 2009 and 2010, it is now recognized that Archean (ca. 3.0-2.7 Ga) tonalitic basement underlies about 60% of Cumberland Peninsula (Figure 2). This recent finding has enhanced the region's prospectivity for diamonds, based on a greater likelihood of underlying old, thick, refractory lithosphere, and the similarity of Cumberland's plutonic rocks to those on Hall Peninsula to the south (*see* Figure 1) where diamond-bearing kimberlites have been recently discovered (http://www.pdiam.com). Discontinuous panels of Archean semipelite ± psammite, amphibolite, rare pillowed volcanic rocks and ca. 2.91Ga quartz porphyritic rhyolite form a minor, yet significant component of Cumberland Peninsula's basement complex.

Younger supracrustal strata, designated the Hoare Bay group (Jackson 1971), were found to be much more restricted than previously thought (Fig. 1; St-Onge et al., 2006), forming a northeast-trending, topographically and structurally high belt across central Cumberland Peninsula (Fig. 2). Minor components of the Hoare Bay Group include marble, calc-silicate and orthoquartzite, whose distribution is mainly limited to the western peninsula and may be the remnants of a shelf succession (Fig. 3). In contrast, ultramafic to mafic volcanic rocks and associated gossanous graphitic pelite, oxide- and silicate-facies iron formation and chert, with thick successions of psammite-semipelite suggest the presence of a basinal facies in the east (Figs. 2, 3). Where exposed, the contact between the Hoare Bay group and basement rocks is intensely deformed, with basement typically comprised of straight mylonite gneiss formed from precursor tonalitic to granitic plutonic rocks, indicative of a mid-crustal tectonic basement-cover contact.

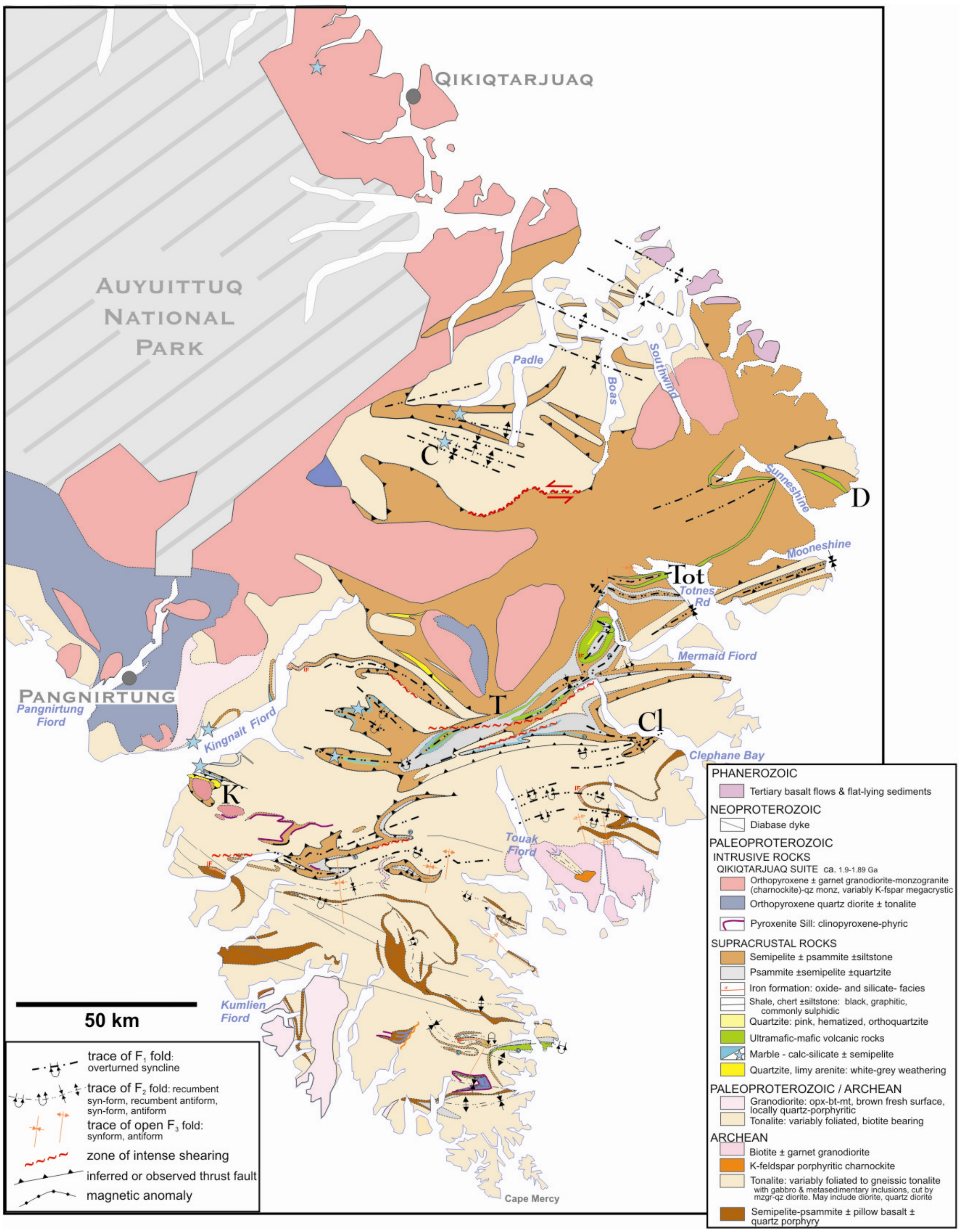

Figure 2. General geology of Cumberland Peninsula showing prevalence of Archean tonalitic basement included with discontinuous panels of supracrustal rocks in the south, in contrast to Paleoproterozoic cover rocks of the Hoare Bay Group in the central, northeast part of the peninsula. Localities within the Hoare Bay group referred to in Figure 3 are designated by letters as follows: Kingnait Fiord (K), Touak Fiord (T), Clephane Bay (Cl), Illikok Island (I), Totnes Road Fiord (Tot), Circle Lake (C) and Cape Dyer (D).

A northeast-trending belt of ca. 1.9 Ga felsic plutonic rocks extends over 200 km from Pangnirtung to Qikiqtarjuaq. This granodiorite-charnockite-quartz diorite suite cuts, and has thermally overprinted, basement and some cover strata.

The rocks exposed on Cumberland Peninsula record at least two penetrative deformation events which have resulted in tight to isoclinal, inclined to recumbent F_2 folds of basement and cover rocks. Where preserved or only weakly transposed, S_1 is generally bedding-parallel, northerly-trending and west- or northwest-dipping. Shallowly to moderately north-dipping S_1+S_2 transposition fabrics and axial planes of F_2 folds reflect widespread south-vergent D_2 structures. Uranium-lead (U/Pb) age constraints, including *in situ* monazite data, all indicate that penetrative tectonometamorphism between 1873 Ma and 1836 Ma event affected most rocks exposed on Cumberland Peninsula, consistent with north-directed convergence during an early stage of the Hudsonian orogeny.

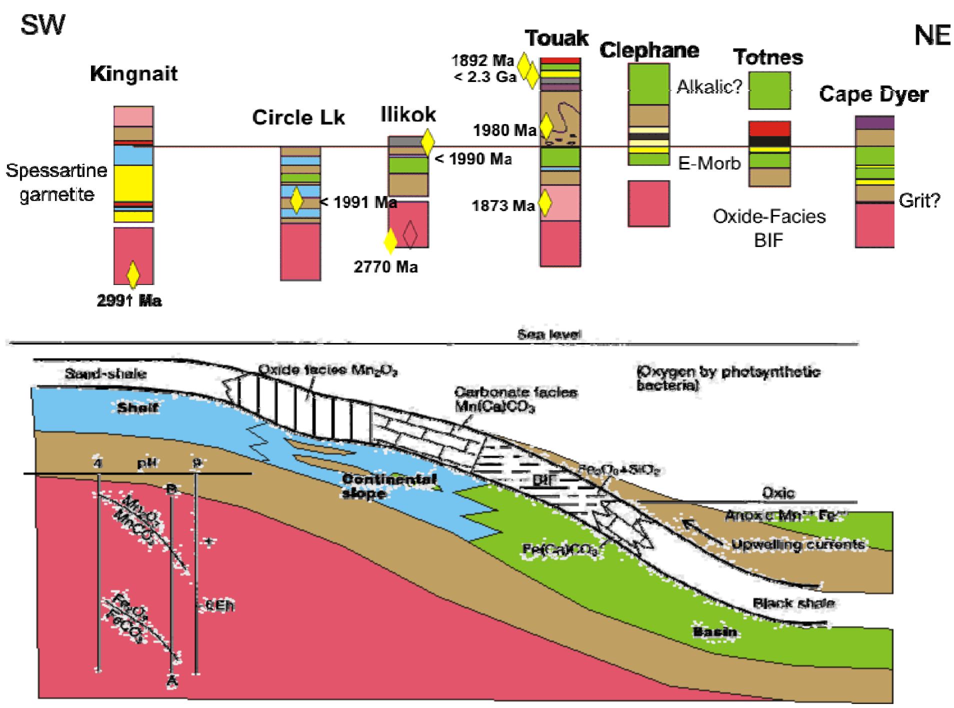

Figure 3. Schematic representation of stratigraphic sections from the Hoare Bay group showing distribution of shelf facies orthoquartzite (yellow) and marble (blue) in the western part of the peninsula, in contrast to basinal facies iron formation (black), volcanics (green) and pelite-semipelite (brown) in the east. Cross-sectional representation of shelf-basin facies transition (from Schissel and Aro, 1992).

Geology and mineral potential of the Hoare Bay group

Supracrustal rocks of the Hoare Bay group are commonly gossanous and sulfide (pyrite-pyrrhotite) bearing. Contents of multiple metals in grab samples from the basinal facies (Fig. 4) are elevated (OF6916_CP_assays.xls) relative to non-gossanous units, highlighting more prospective targets for polymetallic zinc-copper-nickel ±gold mineralization. Some samples of pyroxenite from ultramfic sills show elevated Ni-Cu, indicating prospectivity also for NiCuPGE.

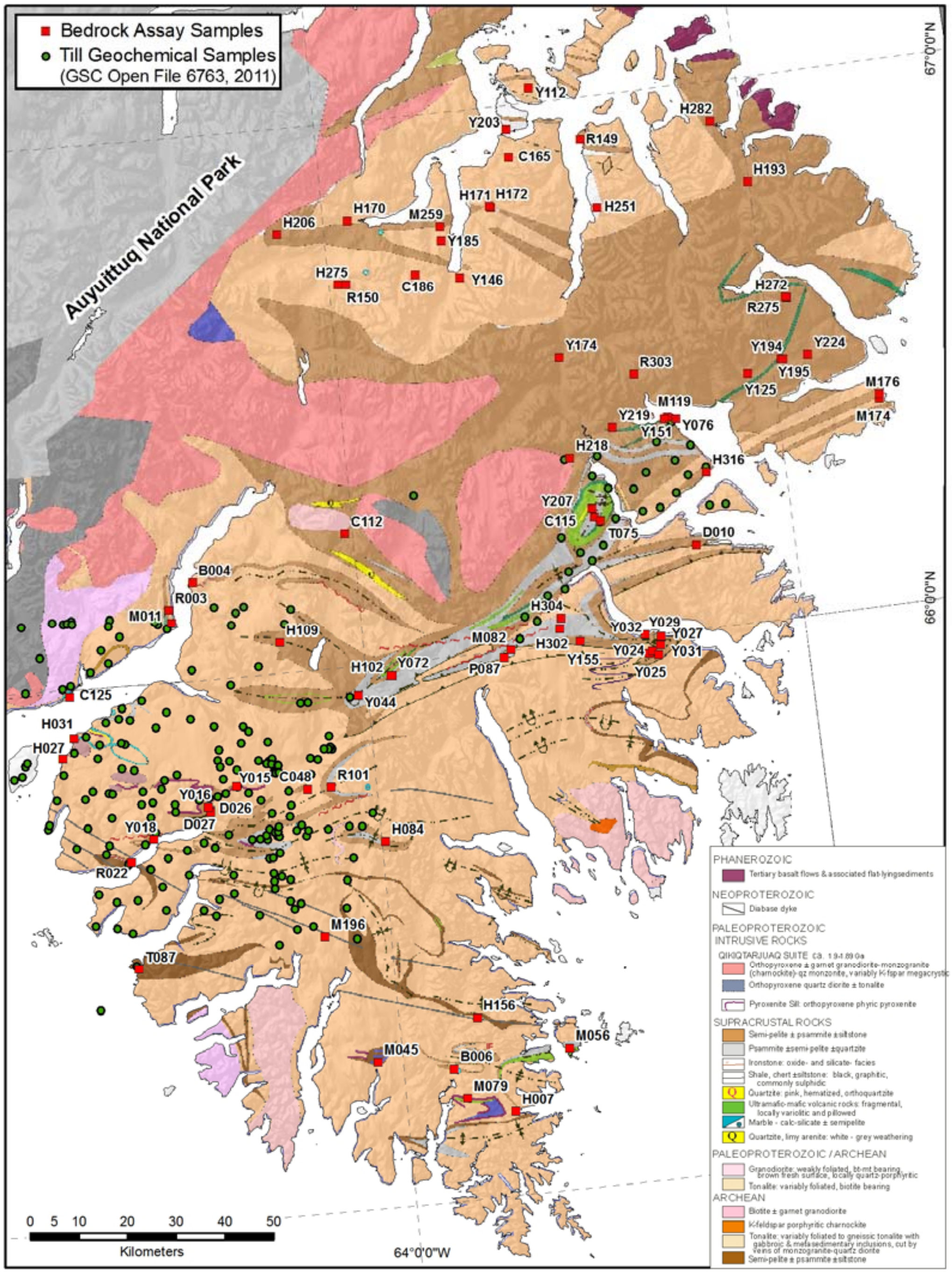

Figure 4: Distribution of gossanous outcrops (red dots) across Cumberland Peninsula from which grab samples were analysed for this study. Lithogeochemiical data for till samples (green dots) can be found in Gammon et al., 2011.

The southern half of the peninsula has recently been the focus of exploration by Peregrine Diamonds Limited, who recently announced the presence of 35 geochemical anomalies and a $300,000 field program in 2011 to follow up on these results (www.pdiam.com). Peregrine highlighted a sulfide-rich boulder sample collected from an area with extensive gossan that analyzed 4.1 g/t silver, 0.3 wt% zinc and 603 ppm copper. Similar results were published in assessment reports by International Capri

Resources following their 3-year exploration program in the mid-1990s, which included coring 3 diamond drill holes in the southern part of the peninsula following promising Zn and Mo results from surface sampling.

Bedrock mapping of Paleoproterozoic cover rocks across the unexplored and more rugged northeastern part of the peninsula in 2010 revealed thicker and more continuous correlative gossanous units than those identified in 2009 to the south. The host rocks to the precious and base metal mineralized localities (Table 1) are a regionally extensive chemical sedimentary unit that may represent an exhalative horizon. The most gossanous, sulfide-bearing, rocks are graphite-rich shale/pelite and chert that have been silica +/- sericite altered and mineralized (pyrite, pyrrhotite, chalcopyrite ± sphalerite). Metal anomalies up to 4.5 wt% Zn, 1.1 wt% Cu, 284 ppb Au, and 3200 ppb Ag are presented in this report.

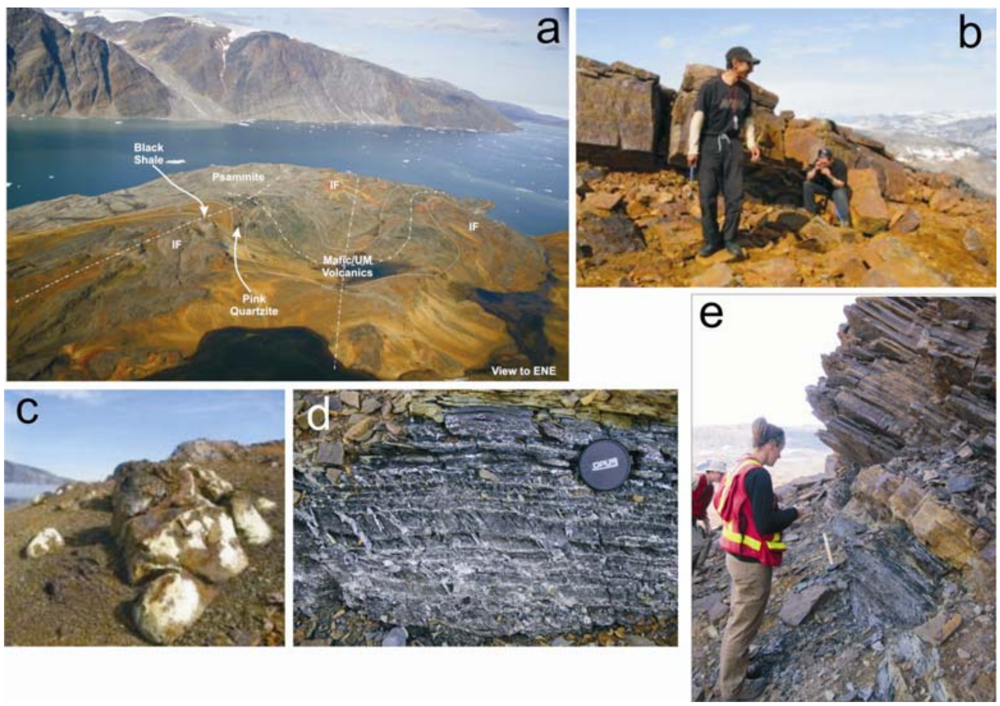

Figure 5. Selected field photographs of gossanous rocks exposed on Totnes Fiord Peninsula. a) view to NE of the peninsula, IF: oxide-facie iron formation UM: ultramafic rocks; b) prospectors from Pangnirtung, Noah Maniapik and Mark Kilabuk, on gossanous chert; c) typical weathering style of spalled rubble reflecting *in situ* graphitic and sulfidic shale; d) close up of graphitic shale/pelite showing bedding- and cleavage-parallel quartz-pyrite-pyrrhotite+/-chalcopyrite veins; and e) GEM Cumberland Peninsula project mappers examining the contact between the lower graphitic shale/pelite, sulfidic chert (orange colour) and upper oxide-facies iron formation.

Conclusions

New regional bedrock mapping as part of the GEM program in 2009 and 2010 has resulted in a vastly improved understanding of the distribution of, and relationships between, the Paleoproterozoic Hoare Bay group cover rocks and Archean tonalitic basement on Cumberland Peninsula. The cover rocks form a coherent northeast-trending sequence across the central, topographically high part of the peninsula. The sequence appears to preserve a shelf facies on western Cumberland Peninsula, and a basinal facies in the east.

Despite broad lithological similarities between the Hoare Bay group and Piling Group, there are important differences that reflect the mineral potential and relevant mineral deposit and exploration models for the area. Both groups are Paleoproterozoic in age, were deposited between about 2.0 Ga and 1.89 Ga (Scott et al., 2003; N. Wodicka pers comm. 2011), and include stratigraphically low orthoquartzite and marble and the predominance of semipelite-psammite. Mafic volcanic rocks in both packages are likely the basinal equivalents of the marble units. Graphitic and sulfidic pelite with semipelite and minor sulfide-facies iron formation, collectively designated the Astarte River Formation in the Piling Group (Scott et al., 2003), overlie marble and are thought to have been deposited on a subsiding underlying carbonate shelf. This graphitic formation may correlate with gossanous, graphitic black shale/pelite of the Hoare Bay group which similarly appears to demarcate a transition from shelf to basinal setting. Important lithologic differences are the Hoare Bay group's distinctive komatiitic suite (Keim et al., in prep.), which is closely associated with gossanous units; and the predominance of chert, also associated with the gossanous units. The Hoare Bay's komatiitic suite is absent from the Piling Group. Preliminary geochronologic data indicate that deposition of at least some metasedimentary rocks associated with the Hoare Bay group occurred after 1.87 Ga (N. Wodicka, personal communication, 2010).

The lithological characteristics and the true thicknesses of prospective metalliferous units vary across Cumberland Peninsula and include the following.

In the west, thin graphitic shale/pelite and manganiferous garnet (spessartite)-rich (>80%) horizons.

In the south, generally discontinuous and widely spaced, 1 to 5 m-thick gossanous graphitic shale, weakly magnetic garnet-grunerite bearing silicate-facies iron formation and minor chert.

In the northeast, 2 to 15 m-thick, generally continuous and traceable along strike, strongly gossanous (pyrite-pyrrhotite-chalcopyrite+/-sphalerite) graphitic shale/pelite, chert and oxide-facies (magnetite) iron formation. The most coherent and thickest exposure of this unit in the north is on the Totnes Road Peninsula (Fig. 5 and frontispiece).

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Appendix I

Sample Preparation

Samples were prepared at the Actlab's Ancaster Ontario laboratory by crushing the entire submitted sample to allow up to 75% to pass through 2mm mesh, followed by mechanical split (riffle) to obtain a representative 250g sample and pulverization (hardened steel to reduce any contamination) to at least 95% minus 150 mesh (106 microns). A cleaner sand was routinely used between each sample.

Analytical extraction/digestion

Gold and other precious metals were analysed by fire assay (FA) which involved mixing an aliquot of powdered sample with soda ash (sodium carbonate), borax (sodium borate), litharge (PbO), flour (baking flour used to add carbon as a reductant), silica, and possible nitre (potassium nitrate). To this mixture, Ag as a collector was added. The well-mixed material was fired at 1150°C. The resultant lead button was cupelled at 950°C in a magnesia cupel. The Ag bead containing Au, Pt and Pd was dissolved and analyzed by inductively coupled plasma mass spectrometry (ICP/MS) using Actlabs code 1Cexpl2 for which detection limits are provided in Table 2.

Table 2. Actlab's Code 1C-Exploration elements and detection Limits (ppb)

Element	Detection Limit	Upper Limit
Au	1	30,000
Pt	0.5	30,000
Pd	0.5	30,000

Base metals and various pathfinder elements associated with mineralization and/or alteration were analysed according to Actlab's code 1H analytical package (Table 3) involving total digestion with analysis by instrumental neutron activation analysis (INAA) and inductively coupled plasma (ICP). Near total digestion, as total as an acid digestion can get but not able to dissolve very resistate phases like chromite, barite, monazite, sphene, xentime, etc., used nitric, perchloric, hydroflouric and hydrochloric acids with temperatures to 260°C.

For the INAA portion, a 30g aliquot of each sample was encapsulated in a polyethylene vial and irradiated with flux wires and an internal standard (1 for 11 samples) at a thermal neutron flux of 7 x $10^{12\ n\ cm-2\ s-1}$. After a 7-day decay to allow Na-24 to decay, the samples were counted on a high purity Ge detector with resolution of better than 1.7 KeV for the 1332 KeV Co-60 photopeak. Using the flux wires, the decay-corrected activities were compared to a calibration developed from multiple certified international reference materials (Hoffman 1992). The standard present was only a check on accuracy and was not used for calibration purposes. 10-30% of the samples were rechecked by re-measurement. For values exceeding the upper limits (Table 2), fire assays better reflect contents. One standard is run for every 11 samples. One blank is analyzed per work order. Selected duplicates are analyzed when enough material is submitted.

For the ICP portion, a 0.25 g aliquot of sample was digested in $HClO_4$-HNO_3-HCl-HF at 260°C to fuming and then diluted with dilute HCl. This leach is partial for magnetite, chromite, barite, spinels, zircon and massive sulphides. The solutions were read on a Varian Vista or Varian 735ES ICP. Reported QC includes a blank analysis frequency of 2%, 1 for every 40 or less samples, a sample replicate frequency of 7%, 1 for every 15 or less samples, and 6% or more are analyzed international standards. Additionally there is an internal method QC with a frequency of 20%.

Table 3: Actlab's code 1H (Au + 48) Elements and Detection Limits

Element	Detection Limit	Upper Limit	Reported By
Au	2 ppb	30,000 ppb	INAA
Ag †	0.3	100,000	ICP&INAA
Al *	0.01%	-	ICP
As	0.5	100,000	INAA
Ba †	50	-	ICP&INAA
Be	1	-	ICP
Bi	2	-	ICP
Br	0.5	-	INAA
Ca	0.01%	-	ICP
Cd	0.3	2,000	ICP
Ce	3	10,000	INAA
Co	1	5,000	INAA
Cr	2	100,000	INAA
Cs	1	-	INAA
Cu	1	10,000	ICP
Eu	0.2	10,000	INAA
Fe	0.01%	-	INAA
Hf	1	-	INAA
Hg	1	1	INAA
Ir	5 ppb	10,000 ppb	INAA
K	0.01%	-	ICP
La	0.5	10,000	INAA
Lu	0.05	10,000	INAA
Mg	0.01%	-	ICP
Mn	1	100,000	ICP

Element	Detection Limit	Upper Limit	Reported By
Mo †	1	10,000	ICP
Na	0.01%	-	INAA
Nd	5	10,000	INAA
Ni †	1	100,000	ICP&INAA
P	0.001%	-	ICP
Pb*	3	5,000	ICP
Rb	15	-	INAA
S	0.01%	20%	ICP
Sb	0.1	10,000	INAA
Sc	0.1	-	INAA
Se	3	-	INAA
Sm	0.1	10,000	INAA
Sn	0.01%	-	INAA
Sr	1	-	ICP
Ta	0.5	10,000	INAA
Tb	0.5	10,000	INAA
Th	0.2	10,000	INAA
Ti	0.01%	-	ICP
U	0.5	10,000	INAA
V	2	10,000	ICP
W	1	10,000	INAA
Y *	1	1,000	ICP
Yb	0.2	10,000	INAA
Zn †	1	100,000	ICP&INAA

Notes: * Element may only be partially extracted.
† Element reported by multiple techniques if one or more techniques may not be total.
Assays are recommended for values which exceed the upper limits.