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Geology of the northern margin of the Trans-Hudson Orogen (Foxe Fold Belt), central Baffin Island, Nunavut

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Abstract

The northern flank of the Trans-Hudson Orogen on central Baffin Island comprises, from north to south 1) reworked Archean basement (Rae Province); 2) the Paleoproterozoic Piling Group, which comprises a lower, passive-margin sequence (Dewar Lakes and Flint Lake formations) and an upper, foredeep sequence (Astarte River and Longstaff Bluff formations); 3) a mafic volcanic thrust sheet (Bravo Lake formation); and 4) a metamorphic-plutonic internal zone. Field relationships suggest that the contact between the Piling Group and the underlying Archean basement is a reworked unconformity. Locally, the contact is obscured by the presence of large biotite syeno- to monzogranite plutons that crosscut both the Piling Group and the Archean basement. Four distinct tectonometamorphic episodes are recorded, with an earlier, middle-amphibolite-facies Archean event (D_{1A}), two compressional Paleoproterozoic events (D_{1P} and D_{2P}), and a late cross-folding event (D_{3P}) that produced a set of basement culminations in the southern portion of the map area.

Résumé

Dans la partie centrale de l'île de Baffin, sur le versant septentrional de l'orogène trans-hudsonien, on observe du nord au sud : (1) un substratum remanié de l'Archéen (Province de Rae); (2) le Groupe de Piling du Paléoprotérozoïque, formé d'une séquence inférieure de marge passive (formations de Dewar Lakes et de Flint Lake) et d'une séquence supérieure d'avant-fosse (formations d'Astarte River et de Longstaff Bluff); (3) une nappe de charriage volcanomafique (Formation de Bravo Lake); (4) une zone interne plutonométamorphique. Les relations observées sur le terrain laissent supposer que le contact entre le Groupe de Piling et le substratum sous-jacent de l'Archéen correspond à une discordance où s'observent des roches remaniées. Par endroits, ce contact est masqué par la présence de grands plutons de syénogranite-monzogranite à biotite qui entrecoupent le Groupe de Piling et le substratum de l'Archéen. Les quatre épisodes tectonométamorphiques distincts qui suivent ont été identifiés : un événement précoce remontant à l'Archéen, qui a donné des roches du faciès des amphibolites intermédiaire (D_{1A}); deux épisodes de compression du Paléoprotérozoïque (D_{1P} et D_{2P}); un épisode tardif de formation de plis superposés (D_{3P}), qui a produit une série de culminations du substratum dans la partie méridionale du secteur cartographique.

INTRODUCTION

This report outlines the preliminary results of a joint Continental Geoscience Division—Canada–Nunavut Geoscience Office 1:100 000 scale bedrock mapping project centred on the Foxe Fold Belt on west-central Baffin Island. The information presented is based on the first of three field seasons that will eventually cover NTS map areas 37 A, 37 D and the western halves of 27 B and 27 C. Fieldwork in 2000 yielded a transect across the map area from 68° to 70° N (approximately 210 km in length) and extending 40 to 100 km inland from the northeastern shore of Foxe Basin (Fig. 1). From north to south, the transect provides a continuous section across the southeastern margin of the Archean Rae Province, the Paleoproterozoic Piling Group, and the northern margin of the ca. 1.86–1.85 Ga Cumberland Batholith.

The first systematic mapping of the area was undertaken at reconnaissance level between 1965 and 1970 (Jackson 1969, 1978, 1984, 2000; Jackson and Taylor, 1972) and in 1974 and 1975 (Morgan et al., 1975, 1976; Jackson and Morgan, 1978; Morgan, 1983). More detailed work was subsequently initiated in the southeastern portion of the map area, in parts of map areas 37 A, 27 B, 27 C and 27 D (Tippett, 1980; Henderson et al., 1988, 1989; Henderson and Henderson 1994). The most recent work in proximity to the current project area consists of bedrock mapping and U-Pb geochronology of Archean rocks in the Eqe Bay area (Bethune and Scammell, 1997) and a lake-sediment and -water regional geochemical survey southwest of the Barnes Ice Cap (Cameron 1986; Friske et al. 1998). The work presented below is based on systematic traverses with approximately 2–3 km spacing.

GEOLOGICAL SETTING

The Foxe Fold Belt lies within the northwestern margin of the Trans-Hudson Orogen on Baffin Island and Melville Peninsula, and correlates with the Rinkian Belt in Greenland (Taylor, 1982; Hoffman, 1988). On Baffin Island, it is flanked to the north by the Archean Rae Province and to the south by the Cumberland Batholith. The main lithological assemblage consists of the Piling Group, which comprises a thin lower sequence of marble, quartzite, schist, and minor iron-formation of platformal facies, and an upper sequence of ferruginous pelite overlain by a large volume of wacke turbidite interpreted as foredeep flysch (Morgan et al., 1976; Henderson et al., 1988; Jackson, 2000). Mafic volcanic rocks have been recognized within the Piling Group (Bravo Lake Formation) and historically interpreted as mafic and ultramafic flows and sills intercalated with the lower sequence of the Piling Group (Tippett, 1980; Henderson et al., 1988; Henderson and Henderson, 1994). Archean basement is interpreted to occur north of the Piling Group as well as in antiformal culminations in the south-southeast region of the map area, near Dewar Lakes (Morgan 1983; Henderson and Henderson 1994). New observations outlined below suggest, however, that at least a proportion of what had been initially interpreted as Archean basement in the Flint Lake and MacDonald River area may in fact comprise Proterozoic intrusions. The following sections outline the results of this past summer's geological mapping, described sequentially from north to south, or from lowermost to highest structural levels.

GEOLOGY

Archean basement

Archean rocks had been previously interpreted to occupy most of the area north of the Piling Group and form continuous basement to the latter (e.g., Morgan, 1983; Bethune and Scammell, 1997). However, this past summer, observations in the vicinity of the basement-cover contact suggest that the latter is encumbered by numerous syn- to post-tectonic felsic plutons of likely Proterozoic age, especially in the area around Flint Lake. Areas underlain predominantly by Archean rocks seem to be restricted to a more northern part of the map, north, west and southwest of Pedro Lake (**Fig. 2**) where they comprise banded tonalitic and granitic orthogneiss, migmatitic granitoid bodies (**Fig. 3**), migmatitic pelitic to psammitic rocks, as well as rare amphibolite. These rocks extend along strike to the southwest in the Eqe Bay area, where they have yielded U-Pb zircon ages ranging between 2.84 and 2.70 Ga (Bethune and Scammell, 1997). The Archean ortho- and paragneiss units are intruded by massive to strongly foliated plutonic rocks of predominantly biotite-granite composition, but include a few intrusions of K-feldspar-megacrystic granodiorite and monzogranite (**Fig. 4**) as well as gabbro-anorthosite. Similar types of intrusions in the Eqe Bay area also yielded Archean ages (Bethune and Scammell, 1997). In the Flint Lake area, as well as in the large area located between Flint Lake and MacDonald River, the distribution of Archean basement is not straightforward. Rocks of the Piling Group were observed either sitting in concordant structural contact above foliated granitoid units (**Fig. 5**), or clearly intruded by them (**Fig. 6**). Throughout most of the area, metaplutonic rocks that sit structurally beneath the Piling Group are foliated, completely recrystallized, and locally migmatitic. In contrast, metaplutonic rocks that intrude the Piling Group are sitting structurally above the latter, are less deformed, and only rarely migmatitic. However, this relationship does not hold in all cases, making the distinction in the field between reworked Proterozoic intrusion and Archean basement a non-trivial task. Total-field aeromagnetic maps of the Flint Lake area (W. Miles; unpub. data, 2000) seem to indicate a rough correlation between areas of potential Archean basement and regions of high magnetic anomalies (see also Jackson, 2000, p.231). This may provide a useful tool to help constrain the extent of exposed Archean basement. Systematic sampling for U-Pb geochronology and tracer isotope geochemistry was undertaken in order to help resolve this problem.

The presence of potential Archean inliers in antiformal culminations in the Dewar Lakes area had been known since the early reconnaissance work of Jackson (1969). This past summer, two other potential basement inliers were identified south and west of Nadluardjuk Lake (**Fig. 2**). They consist of migmatitic orthogneiss and banded gneiss of predominantly felsic composition that are separated from the Longstaff Bluff Formation by a narrow (few tens of metres) unit of banded quartzite, meta-arkose, silicate-facies iron-formation and amphibolite, interpreted as Dewar Lakes Formation. A third area underlain by potential Archean basement occurs east of Western River (see also Henderson et al., 1988).

Piling Group

The Piling Group is continuously exposed from the Flint Lake area to approximately the southern limit of the map area, as well as in narrow bands between MacDonald River and Flint Lake (Fig. 2). In the Flint Lake area, the lower sequence consists of muscovite schist and quartzite intercalated with minor iron-formation (Dewar Lakes Formation), overlain by dolomitic and calcareous marble (**Fig. 7**) with calc-silicate metasedimentary rocks and minor chert (Flint Lake Formation). The upper sequence consists of a basal assemblage of ferruginous psammite, black shale, and sulphide-facies iron-formation (Astarte River Formation) that is overlain by a thick assemblage (few kilometres?) of thin- to thick-bedded psammite, feldspathic wacke, with thin intercalations of semipelite and pelite, and local calc-silicate pods after carbonate concretions (Longstaff Bluff Formation). Wacke horizons in the Longstaff Bluff Formation contain euhedral to slightly rounded, medium-sized feldspar crystals and rounded blue quartz, as well as fine-grained, angular, lithic fragments of supracrustal origin (**Fig. 8**). The association of equidimensional euhedral feldspathic grains and rounded blue quartz suggests derivation, at least in part, from felsic volcanic rocks. Rocks from the lower sequence are mostly concentrated in the Flint Lake area. However, a relatively thin apron of siliciclastic and chemical metasedimentary rocks, which include garnet-biotite schist, quartzite, arkose with sillimanite-quartz nodules (faserkiesel), and iron-formation, occurs between the structural culminations cored by potential Archean gneiss and psammite of the Longstaff Bluff Formation in the southern portion of the map area (Fig. 2). Henderson and Henderson (1994) interpreted a similar association in the Dewar Lakes area as part of the lower sequence.

Volcanic rocks

Mafic to ultramafic volcanic and intrusive rocks and associated sedimentary units occur in an east-west corridor that extends from Straits Bay, to and beyond Western River (**Fig. 2**). In the area investigated this summer, this package occurs in a series of isolated klippen structures preserved by F_{2P}–F_{3P} cross-folding (see below). The largest of these klippen, located southwest of Nadluardjuk Lake (Fig. 2) is characterized by a lower unit several hundred metres in thickness of mostly of mafic and ultramafic cumulate layers and sills. This unit is overlain by a thick (more than 1 km) unit of mafic pillowed, fragmental and massive flows as well as rare mafic to ultramafic sills. Pillow structures are generally very well preserved (**Fig. 9**), and together with paleohorizontal indicators such as pillow shelves (**Fig. 10**), consistently indicate upward-younging directions. Volcanic flows are locally intercalated either with banded calc-silicate rock and mafic sedimentary units, finely laminated meta-siltstone, or rusty psammite and black shales. The contact between the volcanic rocks and the underlying sedimentary rocks of the upper sequence Piling Group is defined by a subhorizontal high-strain zone up to 50 m thick with rare shear-sense indicators (**Fig. 11**) suggesting top-to-the-north-northeast displacement (i.e. thrust fault). Moreover, a highly heterogeneous, highly sheared rock assemblage resembling a tectonic mélange was identified beneath some of the Bravo Lakes Formation klippen (H. Helmstaedt, pers. comm., 2000). This assemblage, measuring up to a few tens of metres in thickness, contains centimetre- to metre-sized blocks of mafic, ultramafic, carbonate, granite, and siliciclastic sedimentary rock in a matrix of predominantly psammitic composition. Note that on Figure 2 we have refrained from interpreting a thrust zone at the base of two of the Bravo Lake formation units occurring in the map area; one on the shore of Straits Bay and the other located northwest of Western River. The basal contact for each of these occurrences was not exposed where traversed this past summer and will need a closer examination.

The volcanic rocks in the Nadluardjuk Lake area were correlated with mafic and ultramafic rocks east of the Western River (Dewar Lakes area) and named Bravo Lake Formation by Tippett (1984). In the Dewar Lakes area, amphibolite, hornblendite and ultramafic bodies of the Bravo Lake Formation have been interpreted as sills emplaced in the lower sequence of the Piling Group by Tippett (Tippet, 1984), Henderson et al., (1988, 1989) and Henderson and Henderson (1994). Fieldwork next summer, as well as a trace- and major-element geochemical study presently in progress, will test the correlation between the volcanic rocks preserved in the set of klippen west and east of Nadluardjuk Lake and the intrusive bodies in the Dewar Lakes area.

Proterozoic plutonic rocks

The Piling Group is intruded by plutonic rocks along its northern and southern margins. Plutons that occur in the north range in maximum diameter from a few hundred metres to a few tens of kilometres, and in composition from biotite syenogranite to monzogranite. They are light pink to beige, medium grained, mostly equigranular, isotropic to strongly foliated, typically exfoliated (**Fig. 12**) and locally contain enclaves and rafts of orthogneiss ((?)Archean) and paragneiss (interpreted as Piling Group). Biotite, which forms up to 15% of the total volume, is the only mafic silicate phase present. Accessory allanite is common, but unevenly distributed. Small ultramafic plugs are the only other intrusive type present. Deformation and metamorphic overprint on the northern Proterozoic plutons are variable, ranging from nearly undeformed and unmetamorphosed, to highly strained, suggesting a syn- to post-tectonic emplacement.

Plutons that occur to the south are compositionally more diverse and have different relative ages. Field relationships suggest that plutons that we correlate with the Cumberland Batholith of Jackson and Taylor (1972) form the oldest intrusive bodies. They consist of a number of grey, medium- to coarse-grained, predominantly K-feldspar-megacrystic elongate plutons of granodioritic to monzogranitic composition. Rapakivi textures have been observed at many locations. Biotite and local hornblende form the main mafic phases (up to 25 %). Garnet is locally present, mostly near contacts with aluminous metasediments. Plutons of the Cumberland Batholith contain enclaves of foliated and folded migmatitic metasediments of the Longstaff Bluff Formation (**Fig. 13**), suggesting that the latter was being deformed and metamorphosed prior to and/or during intrusion by the batholith. Plutons of the Cumberland Batholith are themselves intruded by whitish to light pink, medium-grained to pegmatitic garnet-biotite±muscovite±cordierite leucogranite dykes and plutons. The leucogranites form four major bodies in the southern region of the map area, two of which are in close spatial association with the Cumberland Batholith. As explained below in the metamorphic section, field evidence suggests that the leucogranites are entirely derived from partial to total melting of Piling Group metaturbidites. Pink, exfoliated, biotite syeno- and monzogranites similar to those intruding the north flank of the Piling Group are also found in the southern region of the map area, although they are smaller and less common. They were observed crosscutting the leucogranites.

A unique map-scale feature observed in the area, especially around Flint Lake, is a marked spatial association between Proterozoic plutons and garnet-biotite-muscovite±tourmaline pegmatite, which occurs in abundance in aureoles surrounding the plutons. These aureoles are a few kilometres thick and consist of numerous, discontinuous pegmatite sills injected in Piling Group metasediments. The pegmatites, as well as the metasediments, are structurally concordant with the pluton outlines, and suggest the presence of abundant fluids in the immediate metasedimentary wall rock during pluton emplacement. Similar pegmatites to the ones described here have been observed along strike east of the map area, and have been interpreted as the potential product of shear heating at the interface between Archean basement and Proterozoic cover (G. Jackson; pers. comm., 2000).

METAMORPHISM

The lowest metamorphic grade in the map area is lowermost-amphibolite facies and is located in the central part of the Longstaff Bluff Formation. The grade increases both northwards and southwards from there, with highest pressure-temperature conditions being reached in the southern part of the map area, where uppermost-amphibolite to incipient granulite-facies assemblages occur. To the north, metamorphic conditions reach middle-amphibolite facies at most. The central part of Longstaff Bluff formation is characterized by cordierite+muscovite+biotite±andalusite assemblages in the more pelitic layers and the absence of partial melt. The first appearance of melt is noticed along a roughly east-west isograd south of Nadluardjuk Lake (Fig. 2) and appears to be produced by the reaction muscovite +

plagioclase + quartz ⇒ sillimanite + K-feldspar + melt (Fig. 14). Approximately 10 km further south, along an isograd that is roughly parallel to the one above, breakdown of biotite is observed through the vapour-absent reaction biotite + sillimanite + quartz ⇒ garnet + cordierite + K-feldspar + melt (Fig. 15). This reaction eventually leads to production of large quantities of melt, and we would suggest ultimately the production of garnet±cordierite-bearing granitic plutons. The spatial relationship between the Cumberland Batholith and the highest metamorphic grades observed in the Longstaff Bluff formation, together with the emplacement of the garnet±cordierite leucogranite, appears to be more than fortuitous, indicating that heat input by advection played an important role in the tectonothermal regime of this region. A similar, southward increase in metamorphic facies has also been reported east of the map area in the Dewar Lakes region (Jackson and Morgan, 1978; Tippett, 1984; Henderson et al., 1988).

Towards the north, metamorphic grade in the Piling Group gradually increases from middle- to upper-amphibolite facies, with K-feldspar+sillimanite+melt assemblages observed in metapelitic rocks located between Flint Lake and the MacDonald River. Corresponding parageneses in marble of the Flint Lake formation consist of tremolite+calcite+quartz±diopside±dolomite, with the presence of the latter two phases dependent on bulk rock composition. In the Archean basement rocks, the assemblages hornblende+plagioclase±garnet in rocks of mafic composition and biotite+sillimanite+garnet±melt in rocks of pelitic composition suggest middle- to upper-amphibolite-facies conditions. The fact that Archean plutons crosscut folded migmatitic fabrics suggests that at least part of the Archean metamorphism occurred under mid- to upper-amphibolite facies. However, the intensity of Proterozoic reworking also occurred under high-grade conditions as suggested by the metamorphic overprint of the Piling Group cover on Archean basement. In the Eqe Bay area, the age of Archean metamorphism and Proterozoic overprint is constrained to precede ca. 2.73 Ga and ca. 1.82 Ga, respectively (Bethune and

Scammell, 1997; Jackson and Berman, 2000). In the southern part of the map area, monazites yield ca. 1.81 Ga ages (Henderson and Henderson, 1994), suggesting later exhumation and cooling in the orogen internides.

STRUCTURE

Regional deformation in the map area can be separated into four specific events. The earliest (D_{1A}) was an Archean deformation that was accompanied by middle-amphibolite-facies metamorphism that produced a strong transposition fabric in plutonic and supracrustal protoliths, forming banded gneiss and a penetrative foliation. The original orientation and strain distribution of this tectonothermal event is obscured by younger, partitioned Proterozoic reworking and is best observed locally, where late-Archean intrusions crosscut high-grade fabrics (see also Bethune and Scammell, 1997).

In Piling Group metasediments, early D_{1P} Proterozoic-age convergence produced thin-skinned thrust imbrication, which resulted in duplex-like stacking of the cover sequence (**Fig. 16**). This is well documented in the lower sequence Piling Group where marker horizons are readily available. However, D_{1P} thrust imbrication in the upper sequence Piling Group is more difficult to document due to the absence of obvious stratigraphic markers, but is nonetheless suggested by the presence of sharp, large-scale fold-limb truncations (**Fig. 17**). Another important feature that occurred during this event was the overthrusting of the Bravo Lake Formation onto the Longstaff Bluff Formation. This structural relationship is suggested by the presence of a localized shear zone at the base of the Bravo Lake Formation (described above), and by a flat-ramp geometry observed between the metavolcanic rocks and underlying metasediments. This deformation event was both accompanied by and outlived by peak metamorphic conditions, as suggested by the axial-planar growth of peak metamorphic minerals. The emplacement of the Cumberland Batholith must have occurred during the waning stages of D_{1P}, since leucogranites produced by heat advection from this magmatic event intrude the Bravo Lake Formation. In a regional tectonic perspective, D_{1P} therefore encompassed deposition of the upper sequence of the Piling Group in a foreland basin, initial thrust stacking of cover onto the Archean Rae margin, compressional deformation in the entire Piling Group, overthrusting of the Bravo Lake Formation, and emplacement of the Cumberland Batholith.

The second Proterozoic event (D_{2P}) was largely coaxial with D_{1P} and involved Archean basement (i.e. thick-skinned deformation). It produced predominantly east-west-trending, map-scale, tight to isoclinal, upright to mostly north-vergent reclined and recumbent folds with shallow, doubly plunging axes. It was accompanied by emplacement of biotite granite and garnet-muscovite-biotite±tourmaline pegmatite in proximity to the granite intrusions. Some of the pegmatites crosscut D_{1P} fabrics, whereas other ones are transposed and boudinaged parallel to this fabric, attesting to a syn-D_{2P} emplacement. The unique foliation observed in the biotite granites is parallel to the D_{2P} axial-planar foliation developed in the Piling Group sediment rocks, suggesting that they are syncollisional, in agreement with the relationship observed with the pegmatites. Other evidence pointing to thick-skinned deformation during D_{2P} is the strong parallelism observed between F_{2P} folds in the Piling Group cover and map-scale folds in the Archean basement in the north part of the map area (Fig. 2). This is supported by the presence of monazite, which yields similar U-Pb ages in syn-peak pegmatites in Piling Group metasediments (ca. 1.81 Ga; Henderson and Henderson, 1994); in reworked Archean basement gneiss inliers (ca. 1.81 Ga; Henderson and Henderson, 1994); and in reworked Archean gneiss units immediately to the west of the present map area near Eqe Bay (ca. 1.82 Ga; Bethune and Scammell, 1997). Questions that remain to be resolved are 1) the absolute timing between the emplacement of the Cumberland Batholith, 2) the high-grade metamorphism of the Piling Group, 3) the emplacement of biotite granite, and 4) regional D_{1P}

and D_{2P} deformations. These events appear to be strongly inter-related and may have occurred in sequence during a protracted period. Samples that provide constraints on the timing of these events have been collected for U-Pb geochronology.

The last deformation event of regional importance (D_{3P}) consists of orogen-perpendicular, large-wavelength, upright, open folding which interfered with F_{2P} folds to produce dome and basin structures. This fold interference is responsible for the production of (?)Archean gneiss-cored domes in the south and southeast of the map area (see also Henderson et al., 1988; 1989) and for the preservation of Bravo Lake Formation in synformal basin structures or klippen (this study). F_{3P} folds do not appear to have been accompanied by new metamorphic mineral growth. F_{2P}/F_{3P} fold interference patterns are best developed in the southern third of the map area, a feature also noted by Henderson et al. (1989). In the northern two-thirds of the map area, F_{3P} folds are either absent or obscured by deflection patterns produced by Proterozoic-age intrusions.

ECONOMIC POTENTIAL

There is potential in the area for different types of mineralization, including Pb-Zn in the platformal carbonates of the Flint Lake formation; Ni-Cu-Co-PGEs in the layered mafic-ultramafic sills ot the Bravo Lake Formation; and Sn in pegmatitic aureoles surrounding Proterozoic plutons in the Longstaff Bluff Formation. Important Au and As anomalies were reported in the regional lake sediment geochemical survey (Friske et al., 1998), in close association with bedrock exposure of the Longstaff Bluff Formation. Evidence for sulphide remobilization in the axial planes of F_{2P} folds in the Astarte Lake Formation was observed (**Fig. 18**), suggesting potential mineral concentration during this deformation event. The most interesting prospect to date appears to be the mafic-ultramafic sills for Ni-Co-PGE potential. The sills have an identical age, within error, to the Fox River sills in Manitoba, and are associated with sulphidic metasediments, providing a context potentially similar to that of the Raglan deposit in the Cape Smith Belt (Quebec). Although Henderson and Henderson (1994) attribute little economic interest to these sills, it should be noted that occurrences of disseminated and massive sulphides were noted in the Bravo Lake Formation during the course of our systematic fieldwork.

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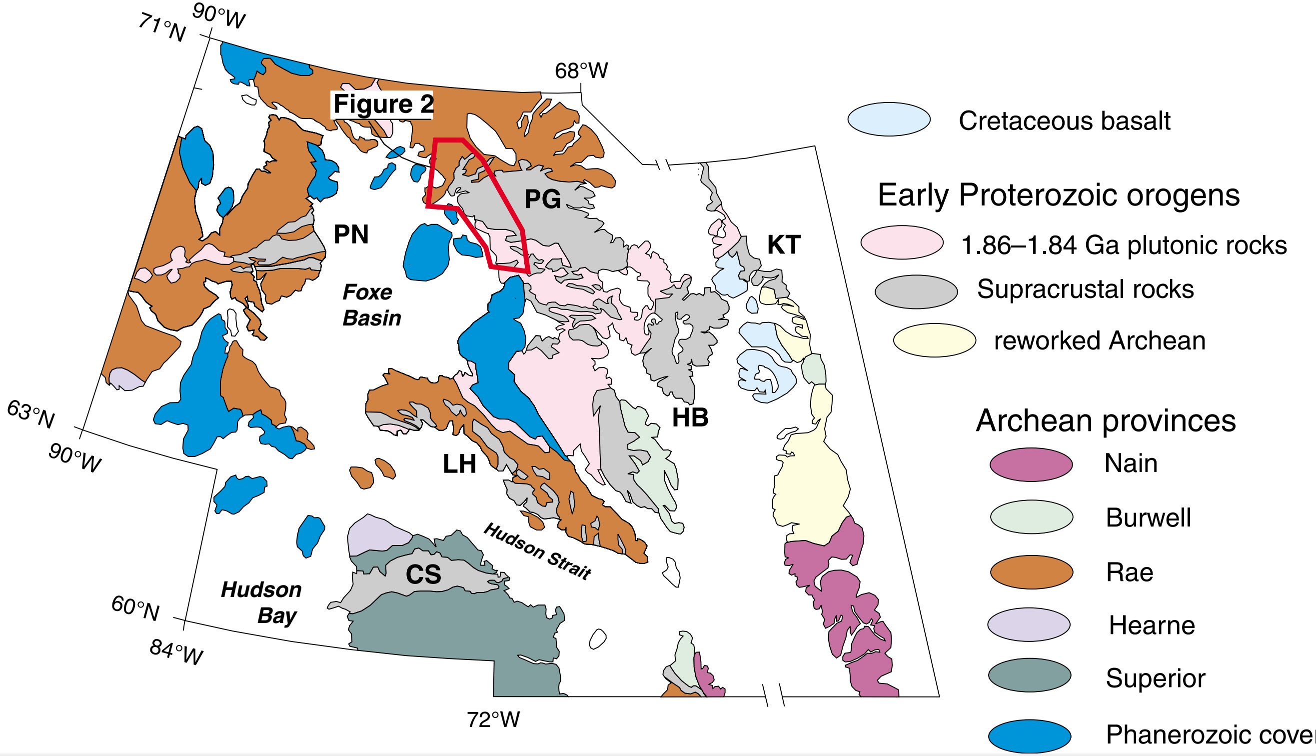

Figure 1. Geological setting of the Foxe Fold Belt in Nunavut. Supracrustal sequences: CS, Cape Smith Belt; HB, Hoare Bay Group; KT, Karrat Group; LH, Lake Harbour Group; PG, Piling Group; PN, Penrhyn Group (*after* Hoffman, 1988).

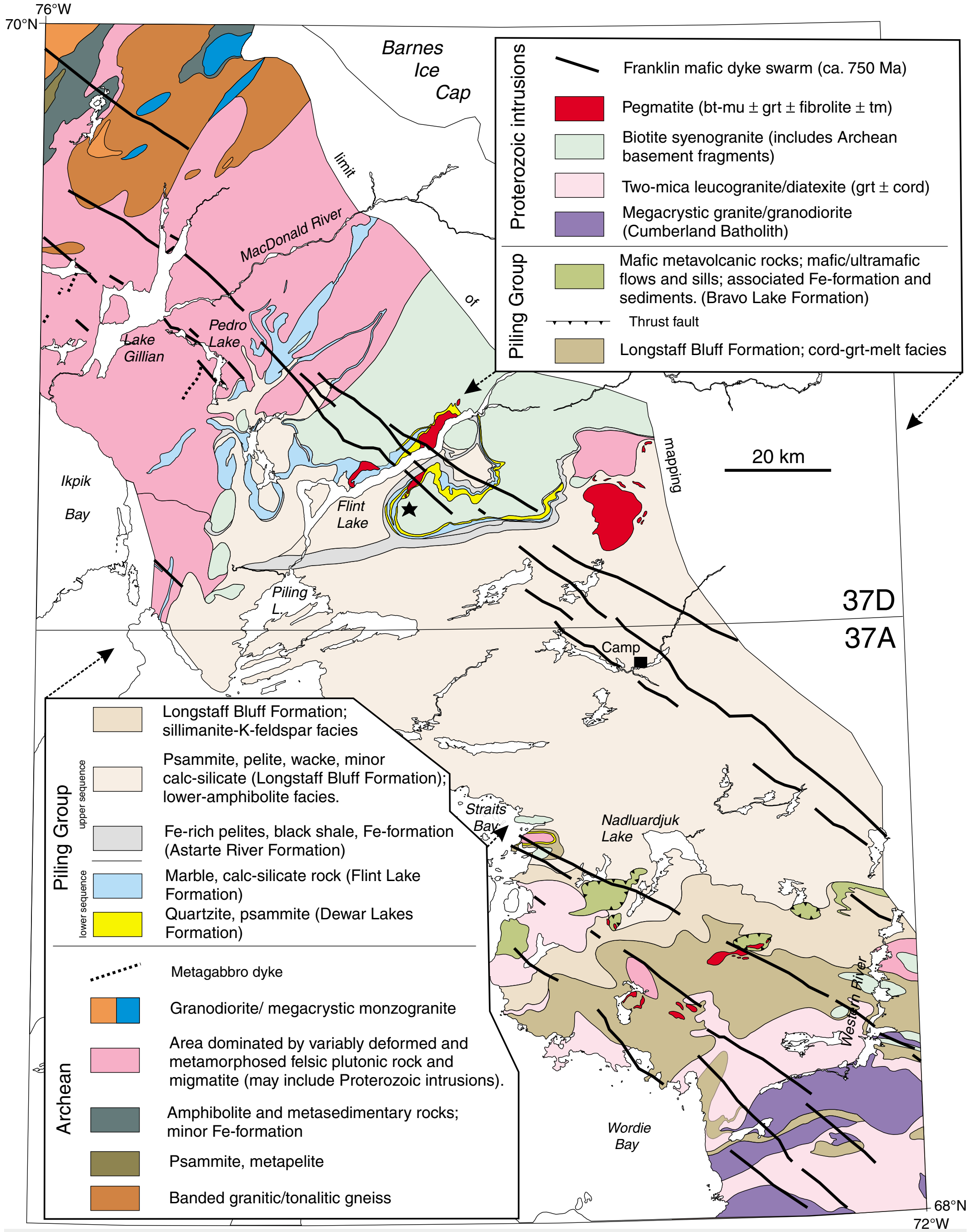

Figure 2. Simplified geological map of part of the Foxe Fold Belt on central Baffin Island. Star symbol southeast of Flint Lake indicates location of observer on Figure 16. Abbreviations: bt, biotite; cord, cordierite; grt, garnet; mu, muscovite; tm, tourmaline.

Figure 3. Migmatitic orthogneiss from the Archean Rae Province north of Lake Gillian. Pen for scale.

Figure 4. Potassium-feldspar-megacrystic monzogranite intruding Archean orthogneiss, which resembles similar intrusions outcropping further to the southwest in the Eqe Bay area, that yielded ca. 2.80 Ga U-Pb zircon ages (Bethune and Scammell, 1997). Coin for scale is 2.2 cm in diameter.

Figure 5. Outcrop photograph of contact between altered, coarse-grained foliated granite representing potential Archean basement (dark grey), and marble of the Flint Lake Formation (light grey). Near coast, north of Longstaff Bluff. Looking west, backpack for scale.

Figure 6. Small cliff face on outcrop approximately 30 km east of Flint Lake, showing medium-grained syenogranite intruding marble of the Flint Lake Formation. White arrow points to intrusive contact. Geological hammer (below and to the right of arrow) for scale.

Figure 7. Outcrop of Flint Lake Formation marble (light grey) with thin, sub-horizontal, foliation-parallel calc-silicate layers (dark grey), located south of Flint Lake. Person for scale.

Figure 8. Close-up photograph of quartzitic and feldspathic wacke, Longstaff Bluff Formation, note the angular to subrounded nature of the feldspar crystals. Outcrop located approximately 20 km east-northeast of Nadluardjuk Lake. Pen for scale is 15 cm long.

Figure 9. Small cliff section on outcrop of the Bravo Lake Formation showing well-preserved pillow structures in basalt. Located in large klippen southwest of Nadluardjuk Lake. Pillow in the centre of photograph is approximately 40 cm wide.

Figure 10. Carbonate-filled pillow shelves marking paleohorizon, in same outcrop as Figure 9. Pen for scale (lying on shelf) is 15 cm long.

Figure 11. Ultramafic boudin (outlined in white pen) at base of klippen of Bravo Lake Formation southwest of Nadluardjuk Lake. Note the flaggy nature of the surrounding mafic metavolcanic rock. Shear sense is top-to-the-north-northeast (dextral on photograph). Hammer for scale.

Figure 12. Proterozoic granite north of Flint Lake. The distinct subhorizontal exfoliation planes that are typical of this suite. Cliff height is approximately 7 m.

Figure 13. Outcrop photograph showing an enclave of psammite from the Longstaff Bluff Formation (middle-right of photograph) enclosed in K-feldspar-megacrystic granite of the Cumberland Batholith (dark grey) that is crosscut by garnet-bearing leucogranite derived from partial melting of the Longstaff Bluff Formation. Hammer for scale.

Figure 14. Outcrop photograph showing incipient, layer-parallel melting in Longstaff Bluff Formation, a few kilometres southeast of Nadluardjuk Lake (*see* text for explanation). Hammer for scale.

Figure 15. Further development of partial melt in Longstaff Bluff Formation, closer to the Cumberland Batholith, with the consumption of biotite in the more pelitic layers and production of garnet±cordierite+melt. Melt formed in stromatic leucosomes segregates in pockets and eventually accumulates to form large intrusive bodies. Magnet for scale is 3 cm.

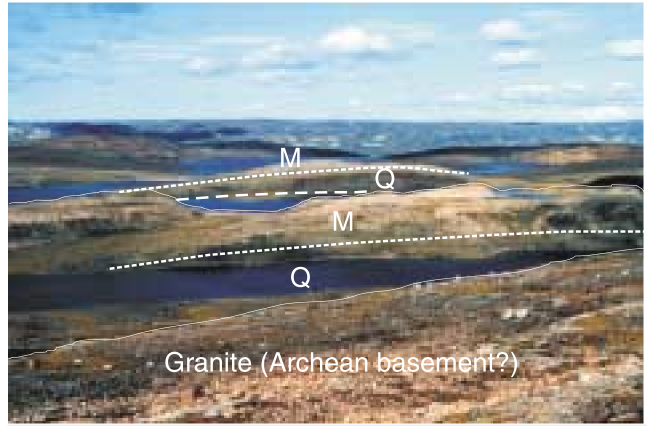

Figure 16. Panoramic view of the lower sequence of the Piling Group, looking north, from the top of a granitic pluton located south of Flint Lake (star symbol on Figure 2), showing the tectonic repetition of basal units of the Piling Group. Dotted line shows the conformable contact between the basal quartzite of the Dewar Lakes Formation (Q on photograph) and marble of the Flint Lake Formation (M on photograph). Thrust plane is marked by the dashed line. Bedding planes dip moderately to the north, away from the observer.

Figure 17. Oblique aerial photograph of the upper sequence of the Piling Group (Longstaff Bluff Formation) showing tectonic truncation of a map-scale F_{2P} fold limb (dashed line). Width at the base of the photograph is approximately 500 m.

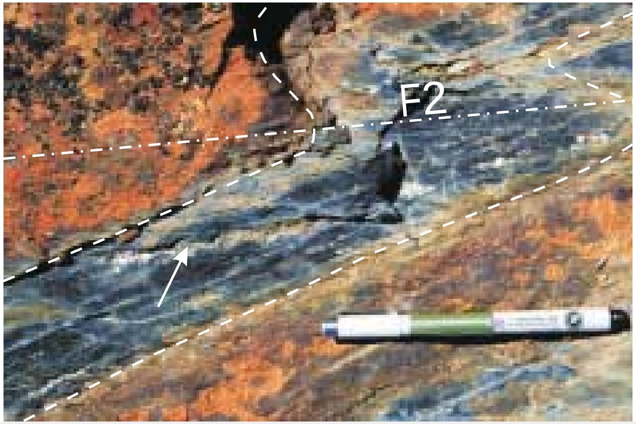

Figure 18. F_{2P} fold in metamorphosed black shale of the Astarte Lake Formation showing the redistribution of sulphide minerals (*see* arrow) along discrete axial-planar bands. Pen for scale is approximately 15 cm long.