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Geology of the Archean Rae Craton and Mary River Group and the Paleoproterozoic Piling Group, central Baffin Island, Nunavut

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Abstract: New mapping (NTS 27 B, C, 37 A, D) has characterized the supracrustal rocks of the Archean Mary River Group and their relationship to the underlying Archean basement orthogneiss units of the Rae Craton. The primary depositional unconformity that separates the base of the Paleoproterozoic Piling Group from the Rae Craton basement has been documented across the project area. The basal, clastic Dewar Lakes formation has been subdivided into 3 informal members. Significant primary variations in thickness of the Dewar Lakes and carbonate Flint Lake formations have been identified throughout the project area. Mafic volcanic rocks and ultramafic to mafic sills interlayered with siliciclastic rocks (Bravo Lakes formation) overlie the basal clastic rocks. Sulphidic pelite (Astarte River formation) overlies the three lowest formations. Psammite-pelite turbidite units (Longstaff Bluff formation) blanket the entire area, and are interpreted as an orogenic molasse. Deformation and consequent metamorphism occurred during the 1.8 Ga Trans-Hudson Orogen.

Résumé : Des nouveaux travaux de cartographie (SNRC 27 B, C, 37 A, D) ont permis la caractérisation des roches supracrustales du Groupe de Mary River de l'Archéen ainsi que de leur relation avec les orthogneiss archéens du socle sous-jacent du craton de Rae. Dans toute la région du projet, il a été démontré que la limite séparant la base du Groupe de Piling du Paléoprotérozoïque du socle du craton de Rae est une discordance sédimentaire. Les roches clastiques basales (formation de Dewar Lakes) ont été subdivisées en trois membres informels. Des variations importantes de l'épaisseur stratigraphique de la formation de Dewar Lakes et de celle de la formation de Flint Lake à lithologie carbonatée ont été identifiées dans la région du projet. Les roches clastiques basales sont surmontées de roches volcaniques mafiques et d'une interstratification de filons-couches mafiques à ultramafiques et de roches silicoclastiques (formation de Bravo Lake). Une pélite sulfurée (formation d'Astarte River) recouvre les trois formations basales. Des turbidites de psammite-pélite (formation de Longstaff Bluff) s'étendent à l'ensemble de la région et constitueraient une molasse orogénique. La déformation et le métamorphisme associé sont reliés à l'orogenèse trans-hudsonnienne (1,8 Ga).

INTRODUCTION

This report presents results from the third and final season (2002) of fieldwork for the bedrock component of the Central Baffin Multidisciplinary Project, a collaborative effort of the Geological Survey of Canada, the Canada-Nunavut Geoscience Office, and the Polar Continental Shelf Project. Results of recent Quaternary mapping are reported in Dredge (2002), electromagnetic work in Evans et al. (2003), teleseismic monitoring in Snyder (2003), petrological studies in Allan and Pattison (2003), and petro-stratigraphic studies in Stacey and Pattison (2003).

The Central Baffin Project area (Fig. 1) is centred on the northern margin of the eastern segment of the ca. 1.8 Ga Trans-Hudson Orogen (Hoffman, 1988), a Himalayan-scale collisional mountain belt that is exposed from Greenland in the east, across Baffin Island and beneath Hudson Bay, to Manitoba and Saskatchewan in the west. The northern part of the area (St-Onge et al., 2001a, b, 2002a, in press a, b) contains various orthogneiss units, metamorphosed sedimentary and minor volcanic rocks of the Mary River Group, and younger felsic plutonic rocks, all of Archean age and ascribed to the Rae Craton (Jackson, 1969, 2000; Bethune and Scammell, 1997, in press; Corrigan et al., 2001; Scott et al., 2002a). The central part of the study area contains siliciclastic, carbonate, and mafic volcanic rocks of the Paleoproterozoic Piling Group (Morgan et al., 1975, 1976; Scott et al., 2002a and references therein), a succession that has recently been described in more detail (St-Onge et al., 2001c, d, 2002b, c, d; Scott et al., 2002a). Various felsic plutonic rocks, ranging in age from 1.90 to 1.85 Ga and including the Cumberland batholith (Wodicka et al., 2002), are exposed in the southern part of the area (St-Onge et al., 2002a). Collectively, the Paleoproterozoic rocks are thought to represent a continental margin succession (Morgan et al., 1975) originally deposited on the southern flank of the Archean Rae Craton and subsequently deformed during Trans-Hudson orogenesis (*see* Corrigan et al., 2001; Scott et al., 2002a; and references therein).

The nature of the contact between the metasedimentary rocks of the Piling Group and the Archean basement rocks varies across the project area. A primary unconformable relationship is preserved along much of the northern margin of the belt; however, where exposed in southern domal structural culminations (Fig. 1), the unconformity is strongly deformed. North of Flint Lake (Fig. 1), Archean orthogneiss is locally thrust onto Piling Group rocks, apparently in association with late thick-skinned folding.

The primary distribution of rock types within the Piling Group varies dramatically across the strike of the belt: carbonate strata (Flint Lake formation) are extensively exposed on the northern margin, whereas mafic volcanic rocks (Bravo Lake formation) are exposed on the southern margin (Scott et al., 2002a; Fig. 1). Regional metamorphic grade increases outward from the central portion of the belt, from subgreenschist facies to incipient granulite facies that is manifested by partial melting of Piling Group rocks (St-Onge et al., 2002a). In the following sections, the rocks are described from lowest to highest structural levels, based on results of new 1:100 000 scale mapping of NTS map areas 27 C (western half) and 37 D (eastern half), as well as on targeted re-examination of key areas across the entire project area.

ARCHEAN RAE CRATON

The rocks of the Rae Craton in the map area comprise dominantly banded granodioritic to monzogranitic orthogneiss, various granodioritic to monzogranitic and rare tonalitic plutons, and siliciclastic and minor mafic volcanic rocks of the Mary River Group.

Orthogneiss

The most common component of the orthogneiss is biotite±hornblende granodiorite to monzogranite, with individual layers ranging in thickness from several centimetres to several metres (Fig. 2a). Biotite±hornblende tonalite layers are present locally; rare mafic layers range in composition from hornblende±biotite diorite to clinopyroxenite. A sample collected from a relatively homogeneous biotite-monzogranite layer of orthogneiss in the vicinity of Dewar Lakes (Fig. 1) yielded a U-Pb crystallization age of 2827 +8/-7 Ma (Wodicka et al., 2002). Similar ages have been reported from the southern margin of the Rae Craton (Bethune and Scammell, 1997, in press, and references therein), supporting the interpretation that the southern domal, structural culminations represent erosional windows that expose the southernmost extent of the Rae Craton (Scott et al., 2002a; St-Onge et al., 2002a).

Plutonic rocks

The layering in the orthogneiss is truncated in numerous localities by weakly to moderately foliated plutonic rocks that range in composition from rare syenogranite to biotite monzogranite to less common tonalite. South of Generator Lake (Fig. 1), a hornblende-biotite mafic tonalite (Fig. 2b) is exposed structurally below an extensive panel of Mary River Group metasedimentary rocks (described in the next section). Several hundred metres away from the supracrustal rocks, the tonalite is medium grained and massive. Near the base of the metasedimentary rocks, the tonalite is an L-S tectonite characterized by a strong down-dip mineral lineation and abundant muscovite (Fig. 2c). Immediately below the panel of Mary River Group rocks, the muscovite-defined fabric is most strongly developed, and is parallel to that developed in the overlying metasedimentary rocks. The progressive increase in the muscovite content of the tonalite may result from potassium metasomatism in proximity to the supracrustal rocks, in which case the tonalite could be viewed as the structural basement to the Mary River Group in this location. Alternatively, the muscovite-rich zone may represent a paleoweathering horizon, suggesting that the contact with the overlying metasedimentary rocks may originally have been an unconformable depositional surface, and that the tonalite represents the stratigraphic basement to the Mary River

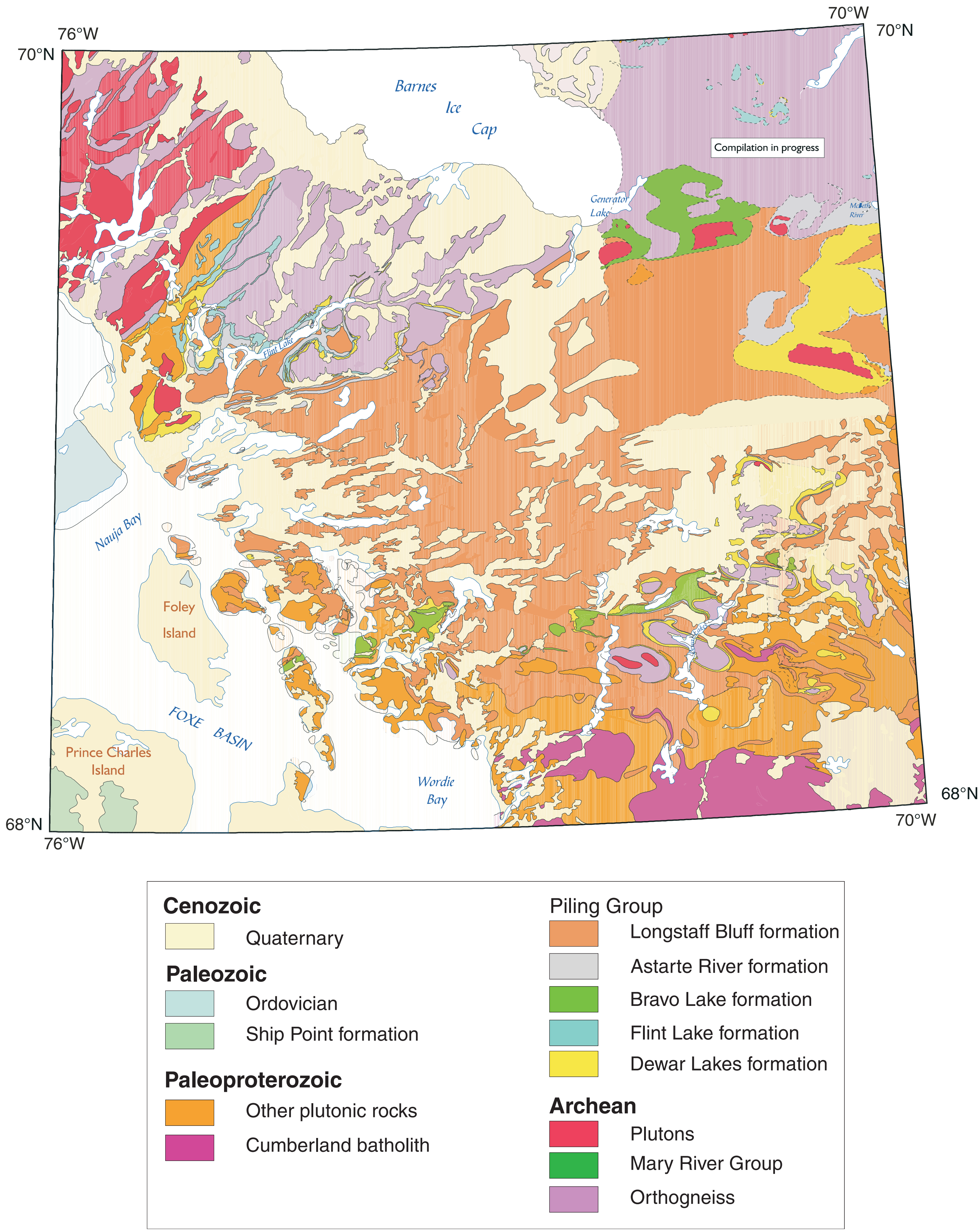

Figure 1. *Generalized bedrock geology of the Central Baffin project area.*

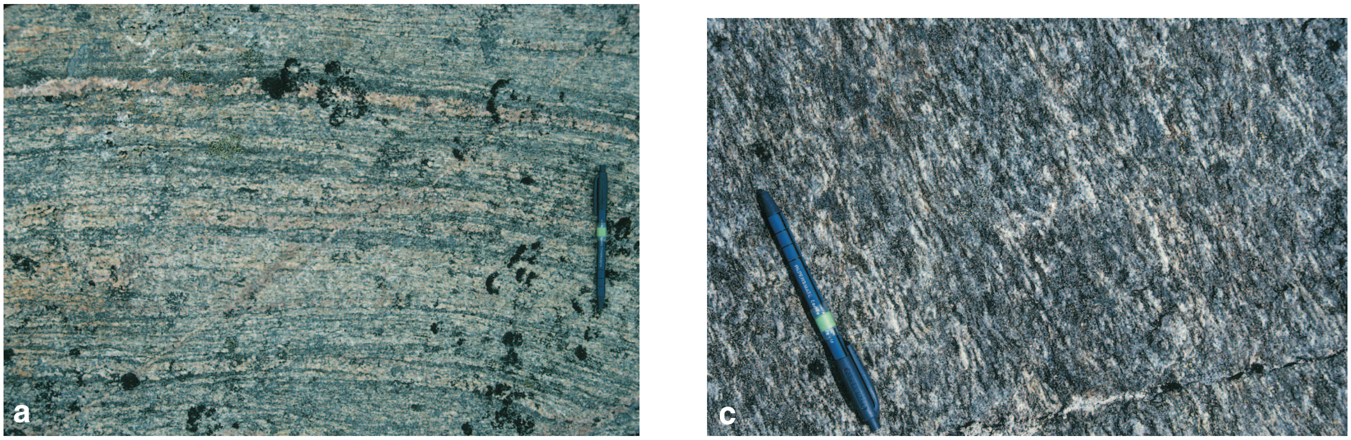

Figure 2.

*Metaplutonic rocks of the Rae Craton. **a**) layered monzogranite-granodiorite orthogneiss (pen is 15 cm long); **b**) hornblende tonalite with minor diorite inclusions, cut by a monzogranite vein (pen is 15 cm long); **c**) foliated hornblende tonalite structurally below metasedimentary rocks of the Mary River Group (pen is 15 cm long); **d**) layered monzogranite-granodiorite orthogneiss (foreground) intruded by massive biotite monzogranite (background), cut by syenogranite pegmatite (pen is 15 cm long).*

Group. The highly strained nature of the rocks at the tonalite–supracrustal rocks contact precludes an unequivocal choice between these two hypotheses. A sample of the mafic tonalite has been collected for U-Pb geochronology.

A variety of monzogranite plutons are present throughout the map area (Fig. 2d). A sample of biotite-allanite monzogranite has been dated at 2738 +25/-21 Ma, and a potassium-feldspar–megacrystic monzogranite gave an age of 2719 +/- 4 Ma (Wodicka et al., 2002). Combined with U-Pb results presented by previous workers (Jackson et al., 1990; *see* Wodicka et al., 2002 for a compilation of results), the interval 2.74–2.72 Ga is emerging as a period of extensive felsic plutonism in the southern Rae Craton.

Mary River Group

Archean siliciclastic and volcanic rocks in the map area are assigned to the Mary River Group (Jackson, 1969, 2000; Bethune and Scammell, 1997, in press), a succession of rocks that are found throughout northern Baffin Island and correlated with similar rocks (the Prince Albert group) along strike to the southwest on the Melville Peninsula (Frisch, 1982).

The most common siliciclastic rock type is brown-weathering psammite, with subordinate quartzite, semipelite, and pelite (Fig. 3a). Development of coarse mica is ubiquitous, imparting a strong schistosity to all units. Coarse knots of sillimanite (±quartz) are commonly developed in beds with more pelitic compositions (Fig. 3b). Exposures of these rocks are commonly rust-stained, due to the oxidation of widespread, fine-grained disseminated pyrite. The brown weathering colour, coarse mica, and generally rusty nature of these rocks readily distinguish them from the siliciclastic rocks of the Piling Group (described in the next section).

Mafic rocks are relatively rare in the map area, in contrast with the area along strike to the west (Bethune and Scammell, 1997, in press). Most are generally massive to moderately foliated, and characterized by hornblende+biotite; clinopyroxene was only rarely observed. At several localities, irregular chloritic banding suggestive of pillow selvages was observed; well preserved pillows have been described along strike by Bethune and Scammell (1997, in press).

PALEOPROTEROZOIC PILING GROUP

Rocks of the Paleoproterozoic Piling Group form part of an extensive package (Jackson and Taylor, 1972) that is exposed as far east as the west coast of Greenland (Karrat Group; Taylor, 1982) and southwestward onto the Melville Peninsula (Penrhyn Group; Henderson, 1983). Because detailed descriptions of the constituent units and references to earlier work have been previously presented (Scott et al., 2002a; St-Onge et al., 2002a), we focus here on newly recognized relationships.

Figure 3. *Siliciclastic rocks of the Archean Mary River Group.* ***a****) psammite, semipelite, and rare quartzite (hammer is 40 cm long);* ***b****) pelite with "knots" of sillimanite (pen is 15 cm long).*

Dewar Lakes formation

The stratigraphically lowest unit comprises white- to grey-weathering quartzite and feldspathic quartzite, locally interbedded with psammite and pelite. The unconformable nature of the basal contact along much of the northern margin of the belt, as well as a three-part subdivision of the Dewar Lakes formation, are described below.

Of paramount importance to the understanding of the tectonic evolution and significance of the Piling Group is the recognition of its primary relationship to the underlying Rae Craton. At numerous widely spaced localities along the

Figure 4.

Dewar Lakes formation, Paleoproterozoic Piling Group. ***a****) basal quartzite unconformably overlying layered monzogranite-granodiorite orthogneiss (foreground; pen is 15 cm long);* ***b****) thinly bedded psammite and quartzite, lower member of the Dewar Lakes formation (hammer is 40 cm long);* ***c****) medium-bedded quartzite, middle member of the Dewar Lakes formation (hammer is 40 cm long);* ***d****) rusty, thinly bedded psammite-semipelite turbidite, upper member of the Dewar Lakes formation (hammer is 40 cm long).*

northern margin of the central belt (Fig. 1), clean exposures of the contact were identified and examined (Fig. 4a). In each case, the basal contact of the Dewar Lakes formation truncates lithological and structural elements in the underlying basement orthogneiss, but is conformable with overlying clastic material (commonly fine- to medium-grained quartzite). Clear primary sedimentary features, such as planar bedding, were commonly observed, suggesting that the overall degree of strain at the contact is negligible. Consequently, we propose that much of the northern contact of the Piling Group against the underlying contiguous Archean rocks (Fig. 1) is an undisturbed unconformity. Recognition of this relationship clearly ties deposition of the Piling Group rocks to the Rae Craton, supporting earlier assertions (Morgan et al., 1975; Scott et al., 2002a) that these rocks collectively represent a Paleoproterozoic continental-margin succession.

The lowest member of the Dewar Lakes formation comprises thinly bedded quartzite, which is commonly rich in coarse muscovite, and grey- to pink-weathering psammite (Fig. 4b); the thickest exposures of this member measure up to ~50 m. Overlying the lowest member is medium- to thick-bedded quartzite (Fig. 4c) containing sillimanite and rare mica. This middle member of the Dewar Lakes formation is by far the most widespread; exposures tens to hundreds of metres thick are common. The upper member of the Dewar Lakes formation is characterized by thin beds of quartzite to psammite and rusty semipelite to pelite (Fig. 4d). The relatively higher proportion of pelitic material in the upper member is consistent with a postulated deeper, perhaps more distal depositional setting (Scott et al., 2002a).

Significant variations in the overall thickness of the Dewar Lakes formation have been identified throughout the project area (Fig. 1). At localities north of Flint Lake, the total thickness of the formation ranges from less than a metre to several tens of metres. In striking contrast, in excess of ~1000 m of quartzite are exposed at the west end of Flint Lake, and similar or greater thicknesses occur south of the McBeth River (Fig. 1). In light of the recognition of an unconformity at the base of the formation, these variations need not be structural in nature, and are consequently interpreted as preserved primary features. One possible explanation is that the areas west of Flint Lake and south of the McBeth River were primary sedimentary depocentres, possibly deltas located at the mouths of rivers flowing off the Rae Craton.

Detrital zircons from a quartzite sample from this formation have a bimodal age distribution: one population is Neoarchean, the other has an age of 2.18–2.16 Ga (Henderson and Parrish, 1992). The Archean detritus is similar in age to known felsic plutonic rocks that form extensive parts of the adjacent Rae Craton (Bethune and Scammell, 1997; Wodicka et al., 2002) and constitute the depositional basement to the Piling Group. The younger grain population brackets the timing of deposition of the entire Piling succession to after 2.16 Ga; the source of this detritus is enigmatic, as extensive exposures of rocks of this age are not known in northeastern Laurentia (*see* Scott et al., 2002b, and references therein). Detrital zircons from additional samples of the Dewar Lakes formation will be analyzed by SHRIMP II ion microprobe (N. Wodicka, pers. comm., 2002) to further delineate the age and provenance of these rocks.

Figure 5. *Dolomitic marble (light) and calc-silicate rocks (dark) of the Flint Lake formation, Paleoproterozoic Piling Group.*

Figure 6. *Rusty, thinly bedded semipelite and pelite of the Astarte River formation, Paleoproterozoic Piling Group (geologist is 185 cm tall).*

Flint Lake formation

White- to grey-weathering dolostone, marble and calc-silicate units of the Flint Lake formation (Fig. 5) are interlayered with minor to rare siliciclastic material (Corrigan et al., 2001; Scott et al., 2002a). The exposed stratigraphic thickness of this formation varies considerably across the map area (Fig. 1). The thickest exposures (500–1000 m), near the west end of Flint Lake, thin toward both the east and west. In the central part of the area, exposures are commonly less than several tens of metres thick, but can be traced along strike for hundreds of metres. Relatively thick exposures are found in the northeastern part of the area (Fig. 1), where thicknesses of tens to hundreds of metres are preserved.

The southernmost exposures, typically thin calc-silicate and marble beds collectively only several metres thick, are no farther than ~40 to 50 km from the northern exposures of continuous Rae Craton. We suggest that the Flint Lake formation originally formed a relatively narrow belt (75–100 km wide) adjacent and parallel to the southern edge of the Rae Craton, with significant along-strike variation in primary thickness.

Bravo Lake formation

In the southern part of the map area (Fig. 1), mafic volcanic rocks as well as mafic and ultramafic sills interbedded with sedimentary rocks are assigned to the Bravo Lake formation (*see also* Stacey and Pattison, 2003). The stratigraphic base of the formation occurs below the mafic volcanic rocks that conformably overlie quartzite, psammite, and rusty semipelite of the upper Dewar Lakes formation (Scott et al., 2002a; St-Onge et al., 2002a). In the northeastern part of the map area (Fig. 1), the northernmost exposures of the Bravo Lake formation are relatively thin sequences (<100 m) of thin flows (or sills) interbedded with (or intruded into) siliciclastic rocks of the upper member of the Dewar Lakes formation.

Because rocks of both the Flint Lake and Bravo Lake formations conformably overlie the siliciclastic rocks of the upper Dewar Lakes formation, we suggest that these lithologically distinct formations occupy the same stratigraphic position in the overall Piling succession. This is further supported by observations (*see* next paragraph) that both the carbonate and mafic volcanic rocks are directly overlain by rusty-weathering graphitic pelite and semipelite assigned to the Astarte River formation.

Astarte River formation

This formation comprises dark, rusty-weathering graphitic pelite and semipelite with minor sulphide-facies iron-formation (Fig. 6). Pyrite and subordinate pyrrhotite are common throughout, occurring as disseminated grains and locally as massive seams. Biotite and graphite are characteristic in the lowest metamorphic-grade rocks, whereas sillimanite and muscovite are present in the highest grade rocks. This formation is estimated to have a maximum overall thickness on the order of 500 m in the northern part of the map area, and pinches out in the vicinity of Dewar Lakes in the south (Scott et al., 2002a; St-Onge et al., 2002a).

In the vicinity of Flint Lake, rusty graphitic pelite of the Astarte River formation is in sharp, conformable contact with underlying marble of the Flint Lake formation (Scott et al., 2002a). Further south (east of Foley Island; Fig. 1), the Astarte River rocks are deposited directly on psammite and rusty semipelite of the upper member of the Dewar Lakes formation (St-Onge et al., 2002a). In the southernmost parts of the area, the rusty graphitic pelite overlies mafic volcanic rocks of the Bravo Lakes formation. The dramatic change in the nature of the stratigraphic units underlying the Astarte River formation further emphasizes the across-strike variation in the paleogeographic distribution of the lowest units of the Piling Group.

Longstaff Bluff formation

The Longstaff Bluff formation comprises a relatively homogeneous package of distinctly feldspathic psammite, subordinate semipelite, and rare pelite turbidite (Scott et al., 2002a). Bedding thickness is typically 10 to 50 cm (Fig. 7a), but can be as much as 2 to 3 m in extreme cases. Graded bedding is commonly preserved in the thinner beds (Fig. 7b), indicating that most of the succession is upright, with overturned beds found only on oversteepened fold limbs (St-Onge et al., 2002a, in press a, b). Calc-silicate pods up to several tens of centimetres in diameter are ubiquitous throughout the psammitic beds of this formation, and are interpreted as metamorphosed carbonate concretions (Fig. 7c). Elongate undulose features on bedding planes, interpreted as ripple marks (Fig. 7d), have been observed at only a few locations and are typically oriented roughly east–west.

The Longstaff Bluff formation turbidite units abruptly overlie the Astarte River formation in the north, the Bravo Lake formation in the central part of the area, and the Dewar Lakes formation quartzite units in the south. Neodymium isotopic analysis (Johns, 2002) has demonstrated that these rocks have a distinctly younger provenance than those of the Dewar Lakes formation. Detrital zircons from samples of this formation will be analyzed by SHRIMP II ion microprobe (N. Wodicka, pers. comm., 2002) to attempt to characterize the provenance of the sediments and bracket the timing of their deposition. We tentatively interpret the rocks of the Longstaff Bluff formation as a molasse resulting from orogenic uplift and erosion.

PROTEROZOIC PLUTONIC ROCKS

Three varieties of plutonic rocks intrude the Piling Group and underlying Archean basement. The volumetrically most important are the massive to weakly foliated felsic plutonic rocks of the Cumberland batholith that are widespread in the southern part of the map area (Fig. 1). A potassium-feldspar–megacrystic monzogranite sampled east of Wordie Bay has been dated at 1897 +7/-4 Ma (Wodicka et al., 2002); this age is ~ 30 Ma older than that obtained for similar rocks in the southern part of the Cumberland batholith (Scott, 1999), and may represent a pre–Cumberland batholith magmatic event.

The second variety of igneous rocks comprises pegmatitic syenogranite to monzogranite dykes, sills, and irregularly shaped plutonic masses that commonly contain muscovite, garnet and biotite. These intrusions occur throughout the map area, and were emplaced over a time interval ranging from the thermal peak of metamorphism to the latest thick-skinned folding events (Fig. 8a, also Fig. 2d).

Undeformed and unmetamorphosed diabase dykes of the northwest-trending 723 +4/-2 Ma (Heaman et al, 1992) Franklin swarm are widespread across the map area. These vertical dykes range in width from several metres to hundreds of metres; the thickest dykes can be traced continuously for tens of kilometres (Fig. 8b).

DEFORMATION AND METAMORPHISM

The Archean tectonothermal history of the Rae Craton has been described in detail by Bethune and Scammell (1997, in press) based on work immediately to the west of the current map area. Overviews of the area north of Flint Lake have recently been presented (Corrigan et al., 2001; St-Onge et al., 2001a, b).

Tight, intrafolial isoclinal folds of bedding in siliciclastic rocks of the Dewar Lakes formation represent evidence of the earliest Paleoproterozoic deformation in the map area (D_{1P}). In the vicinity of Dewar Lakes, the contact between the Archean orthogneiss and the overlying quartzite is highly strained, and commonly an intense, northwest-trending mineral lineation is developed. The underlying orthogneiss is also strongly recrystallized, with planar, contact-parallel fabric development intensifying toward the contact with the overlying quartzite. Shear-sense indicators are rare, making it difficult to systematically document the sense of displacement. Tectonic imbrication of the lowest formations of the Piling Group in the Flint Lake area, and structural juxtaposition of rocks of the Dewar Lakes and Bravo Lake formations onto Longstaff Bluff formation turbidites in the southern part of the area (St-Onge et al., 2002a; Fig. 1), are both interpreted to have occurred during D_{1P} (Scott et al., 2002a).

Macroscopic, northeast-trending folds of Piling Group rocks and underlying basement units are ascribed to D_{2P}. The axes of these folds typically have shallow plunges, and axial surfaces vary from upright to slightly inclined (Fig. 9). The fold closures are typically tight and angular. At several localities, orthogneiss units of assumed Archean age have been overthrust northward onto rocks of the lower Piling Group (Fig. 10); this is interpreted as a consequence of overtightening of D_{2P} folds. The basement-involved, thick-skinned D_{2P} folds are refolded (D_{3P}) by northwest- to northeast-trending, upright cross folds that generate the overall dome-and-basin geometry of the map area (Fig. 1).

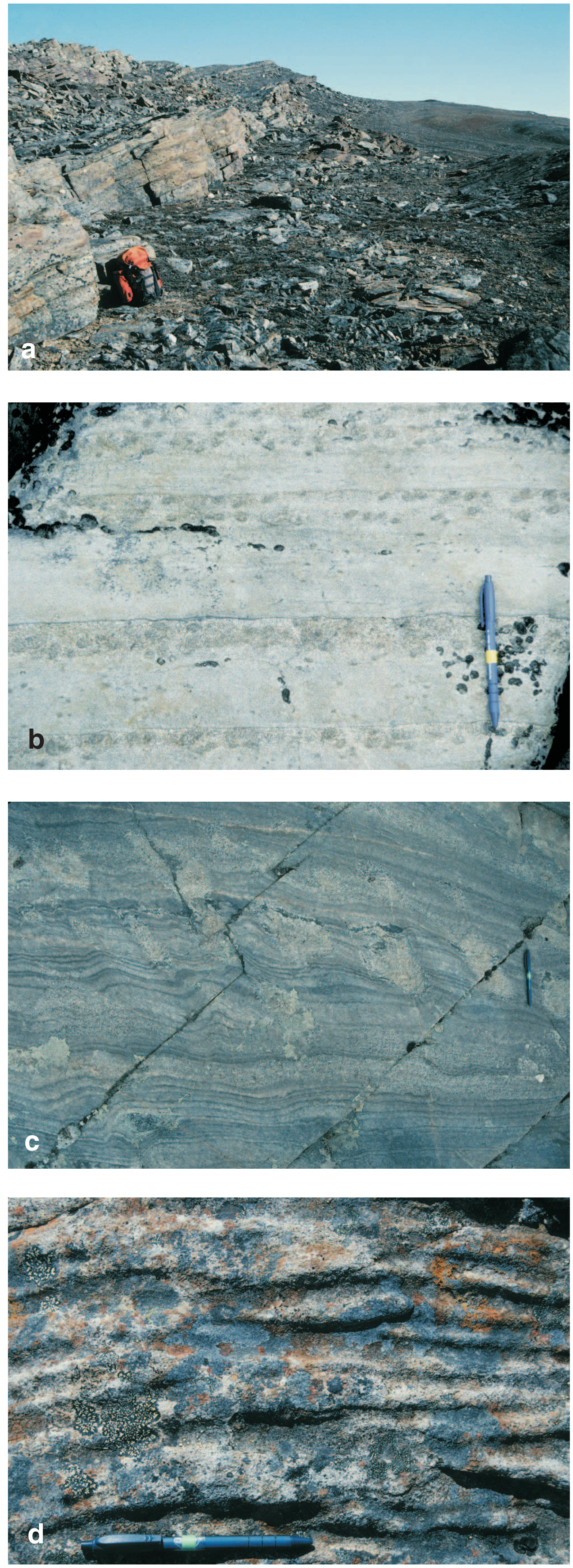

Figure 7.

Longstaff Bluff formation, Paleoproterozoic Piling Group. ***a****) ledge-forming psammite-semipelite turbidite (left) overlying rusty pelite of the Astarte River formation (packsack is 55 cm tall);* ***b****) turbidite beds preserving quartz- and feldspar-rich bases grading to more aluminous tops that are characterized by cordierite porphyroblasts (pen is 15 cm long);* ***c****) thinly bedded turbidites with concretions (pen is 15 cm long);* ***d****) ripple marks in a sandy bed; view is perpendicular to bedding plane (pen is 15 cm long).*

Figure 8.

Proterozoic intrusions. ***a****) late, horizontal syenogranite pegmatite;* ***b****) diabase dyke of the 723 Ma Franklin swarm.*

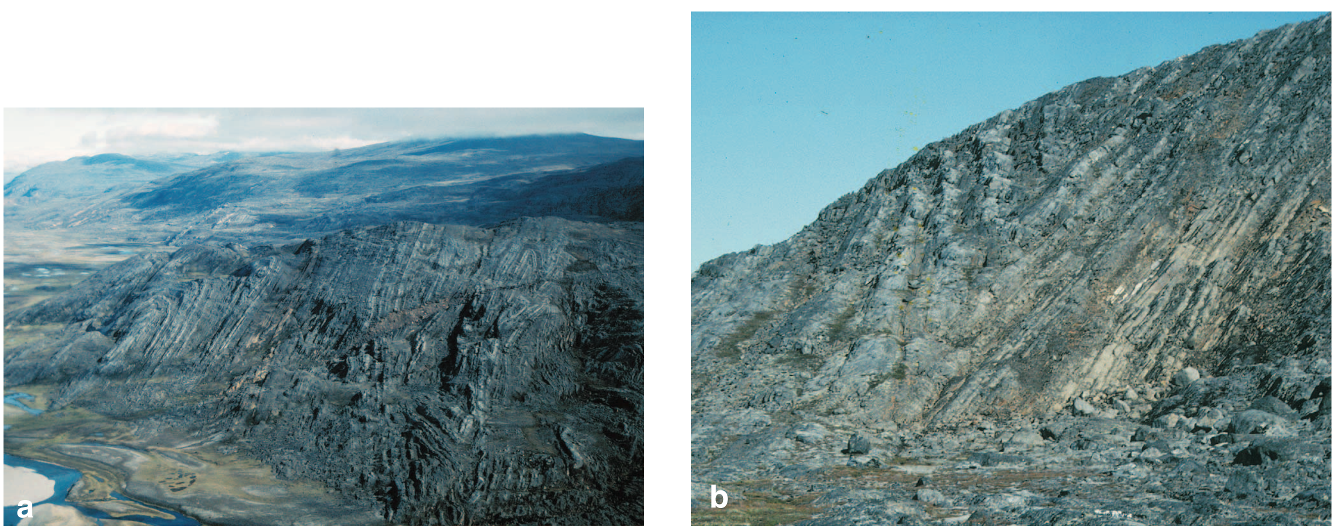

Figure 9. *Folds of Paleoproterozoic Longstaff Bluff formation turbidite.* ***a****) oblique view from the air;* ***b****) in profile, showing upright to shallowly overturned axial-planar surfaces.*

Figure 10. Layered monzogranite-granodiorite orthogneiss (interpreted as Archean) thrust onto marble of the Paleoproterozoic Flint Lake formation as a consequence of late, thick-skinned folding.

Mapping in the eastern part of the map area has allowed documentation of the closure of metamorphic mineral zones, essentially outlining a “thermal trough” roughly centred on the belt of Piling Group rocks (Fig. 1). Mineral assemblages in pelitic rocks progressively increase in metamorphic grade in a broadly concentric pattern (St-Onge et al., 2002a, in press a, b), from chlorite-muscovite through biotite-muscovite, biotite-muscovite-cordierite±andalusite, locally muscovite-sillimanite, then K-feldspar–sillimanite–melt, and ultimately to garnet–cordierite–K-feldspar–melt (adjacent to the Cumberland batholith). The present complex geometry of the mineral zones is interpreted as a consequence of interference between D_{2P} and D_{3P} fold events.

ECONOMIC GEOLOGY

The Paleoproterozoic rocks of the project area hold elevated potential for a variety of mineral deposit types. These include Mississippi-Valley–type Zn in the relatively thick carbonate units (Flint Lake formation), and sedimentary-exhalative (SEDEX) base-metal deposits in the overlying graphitic pelite (Astarte River formation). The mafic and ultramafic rocks of the Bravo Lake formation are exploration targets for Ni-Cu-PGE magmatic sulphide deposits. Upper–amphibolite-facies siliciclastic rocks of the upper Dewar Lakes formation have potential for Broken-Hill–type Pb-Zn-Ag deposits. In the northeastern part of the area, syenogranitic pegmatite bodies that intrude the lower part of the Longstaff Bluff formation have potential for Sn-Ta mineralization.

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