PRECAMBRIAN METAMORPHIC AND TECTONIC EVOLUTION
OF NORTHERN BAFFIN ISLAND, NUNAVUT, CANADA*

GARTH D. JACKSON AND ROBERT G. BERMAN§

Continental Geoscience Division, Geological Survey of Canada, 615 Booth Street, Ottawa, Ontario K1A 0E8, Canada

ABSTRACT

The northern part of Baffin Island, in Nunavut, lies within the ca. 3.0–2.5 Ga Committee belt, characterized by episodic granitic plutonism and greenschist- to upper-amphibolite-facies belts of supracrustal rocks. Whereas the entire belt on Baffin Island was likely affected by ca. 2.7 Ga plutonism and associated metamorphism, there is also evidence of a high-grade event at ca. 2.55–2.5 Ga. Evolution of the Baffin orogen in south-central Baffin Island led to generation of the ca. 1.86 Ga Cumberland Batholith, ca. 1.85–1.83 Ga northwest-directed thrusting of the Foxe fold-and-thrust belt over the Dexterity granulite belt (DGB), and variable structural and metamorphic reworking of the Committee belt on northern Baffin Island. Thermobarometric data for granulite-facies rocks in the western DGB indicate ~8.7 kbar paleopressure, interpreted to have been achieved in continental crust thickened by thrust imbrication. Paleopressure decreases gradually northward from the western DGB to <4 kbar, but decreases sharply south of the Isortoq fault zone (IF), which approximates the southern boundary of the DGB. Combined thermobarometric and structural constraints suggest that the IF represents an important crustal-scale structure involved in both NW-directed thrusting and tectonic loading of the DGB, as well as subsequent extensional unroofing of the DGB. Southwest-directed thrusting in the ca. 1.825–1.81 Ga Northeast Baffin thrust belt (NBTB) is interpreted to have produced similar tectonic thickening and ~10.5 kbar pressures along most of the length of this belt on northern Baffin Island, including the eastern part of the DGB. The ~6–8 kbar Archean Bylot Batholith represents a higher structural level that may have contributed to tectonic loading of adjacent high-pressure rocks in the NBTB.

Keywords: Baffin Island, metamorphism, tectonics, P–T data, thermobarometry, Committee belt, Baffin orogen, Nunavut.

* Geological Survey of Canada contribution number 2000015.
§ E-mail address: rberman@nrcan.gc.ca

La partie nord de l’île de Baffin, au Nunavut, se trouve à l’intérieur de la ceinture Committee, dont l’âge serait d’environ 3.0–2.5 Ga; ce socle témoigne d’épisodes de plutonisme granitique et contient des ceintures métamorphiques de roches supracrustales recristallisées aux conditions allant des faciès schistes verts à amphibolite supérieur. Tandis que la ceinture en entier sur l’île de Baffin a subi un épisode de plutonisme et de métamorphisme associé à environ 2.7 Ga, il y a aussi des signes d’un métamorphisme de haut grade à environ 2.55–2.5 Ga. L’évolution de l’orogène de Baffin dans le secteur centre-sud de l’île a mené à la mise en place du batholite de Cumberland à environ 1.86 Ga, au chevauchement vers le nord-ouest à environ 1.85–1.83 Ga de la ceinture de Foxe, imbriquée par-dessus la ceinture granulitique de Dexterity, et au remaniement structural et métamorphique d’intensité variable de la ceinture Committee plus au nord. Les données thermobarométriques pour les roches du secteur ouest de la ceinture Dexterity indiquent environ ~8.7 kbar de pression, qui serait dû à un épaississement de la croûte continentale suite au chevauchement et à l’imbrication. Les pressions diminuent graduellement vers le nord à partir de la ceinture Dexterity (secteur ouest) jusqu’à moins de 4 kbar, mais elles diminuent abruptement au sud de la zone de faille Isortoq, qui marquerait la bordure sud de la ceinture Dexterity. D’après les données thermobarométriques et les contraintes structurales, la zone de faille Isortoq représenterait une structure importante à l’échelle de la croûte, impliquée à la fois dans le chevauchement vers le nord-ouest et l’empilement tectonique sur la ceinture Dexterity, de même que la remontée de ce socle en milieu d’extension par la suite. Un chevauchement vers le sud-ouest à environ 1.825–1.81 Ga le long de la ceinture du Nord-Est de Baffin aurait produit un épaississement semblable et des pressions d’environ 10.5 kbar tout le long de cette ceinture dans la partie nord de l’île, et en aurait affecté la partie orientale de la ceinture Dexterity. Le batholite archéen de Bylot, témoignant de pressions d’environ 6–8 kbar, représente un niveau structural supérieur qui pourrait avoir contribué à l’empilement tectonique par dessus les roches de pression élevée avoisinantes de la ceinture de chevauchement du Nord-Est de Baffin.

(Traduit par la Rédaction)

Mots-clés: île de Baffin, métamorphisme, évolution tectonique, données P–T, thermobarométrie, ceinture Committee, orogène de Baffin, Nunavut.
INTRODUCTION

The geology of most of Precambrian Baffin Island is known only at reconnaissance scale, based in large part on four Geological Survey of Canada helicopter mapping projects with flight lines and landings at ~10 km intervals (e.g., Blackadar 1967, 1970, Jackson & Taylor 1972, Jackson & Davidson 1975, Jackson et al. 1975, Jackson 2000). More detailed mapping and associated studies have largely been restricted to central and southern Baffin Island (e.g., Morgan et al. 1976, Tippett 1980, Henderson et al. 1989, St-Onge et al. 1999, 2000), with the exception of the Eqe Bay area (Bethune & Scammell 1997). Although the distribution of metamorphic facies and the main overprinting relationships have been described at reconnaissance scale for Baffin Island (Jackson & Morgan 1978a), more detailed studies with associated U/Pb geochronology have been restricted to portions of southern Baffin Island (St-Onge et al. 2000), a small area in central Baffin Island (Henderson et al. 1989, Henderson & Henderson 1994), and the Eqe Bay area (Bethune & Scammell 1997). Except for southernmost Baffin Island (St-Onge et al. 2000), quantitative constraints on metamorphic conditions are known only for one other small area of south-central Baffin Island (Cortemiglia et al. 1985).

In this paper, we address this gap in metamorphic knowledge by presenting the first reconnaissance-scale thermobarometric constraints for northern Baffin Island. We first describe geological relationships, tectonic domains, and regional-scale metamorphic relationships on northern Baffin Island. We then summarize what can be inferred about its tectonometamorphic history, relating metamorphic tectonites in Archean and Paleoproterozoic lithologies to major tectonic domains and domain boundaries. We begin with a brief overview of the geotectonic setting of Baffin Island.

GEOTECTONIC SETTING

Baffin Island can be divided into two blocks with contrasting geological histories. The northern part consists of the ca. 3.0–2.5 Ga Committee belt (the Committee Fold Belt of Jackson & Taylor 1972), which lies within the northern Churchill Province (Stockwell 1982) or the northern Rae Province (Hoffman 1989). This belt extends northeast for at least 2000 km from southwest of Baker Lake to northwestern Greenland (Fig. 1). It is characterized by episodic felsic plutonism and greenschist- to upper-amphibolite-facies supra-crustal belts. The ca. 1.9–1.8 Ga Baffin orogen comprises the rest of Baffin Island, extending into northern Baffin Island, where it overprints the Committee belt. The Baffin orogen forms part of the northeastern Trans-Hudson orogen, and extends into western Greenland, Melville Peninsula, and northern Quebec–Labrador (Fig. 1; Henderson et al. 1980, Hoffman 1990a, b, Jackson et al. 1990a, b, St-Onge et al. 1999, Jackson 2000).

In addition to these two main lithotectonic units, Baffin Island has been divided into eight tectonic domains on the basis of differences in aeromagnetic character, structural features, lithologies, faults and lineaments, and extant geochronology. In northern Baffin Island, there is general continuity in lithologies across these domain boundaries, with the exception of several basins that consist of younger sediments. For this reason, tectonic domains and important boundaries between domains are described after the geological relations within the Committee belt and Baffin orogen. Descriptions of geological relationships (Fig. 2) and tectonic domains (Fig. 3) are based largely on the work documented and referenced in detail by Jackson (2000), who also presents a comprehensive list of geological maps and geochronological results for the region. All reported ages are U–Pb zircon ages unless otherwise noted.

GEOL OGY OF THE COMMITTEE BELT

The geology of much of the Committee belt (Fig. 1) is known at a reconnaissance scale only. Extant geochronology indicates that it is characterized by three Archean crust-building episodes. The oldest (ca. 3.0–2.8 Ga) is represented by a ca. 2.85 Ga felsic pluton on northwestern Baffin Island (Jackson et al. 1990b) and ca. 2.9 Ga felsic volcanic rocks on Melville Peninsula (Frisch 1982, Henderson 1983). In addition, the presence of old crust is indicated by ca. 3.0 Ga zircon...
PALEOPROTEROZOIC

- Dexterity Granulite Belt (1.825 Ga); reworked Archean and some Paleoproterozoic rocks
- Granite-tonalite, charnockite-enderbite plutons (1.87-1.81 Ga, c= Cumberland Batholith)
- Thelon Tectonic Zone; reworked Archean, 2.0 - 1.9 Ga granitic, and charnockitic intrusions, supracrustal rocks of uncertain age
- Supracrustal rocks and derived gneisses (2.2 - 1.8 Ga); includes some small Paleoproterozoic granitic plutons, and reworked Archean rocks; Nagssugtoqidian Mobile Belt is shown by stippling

ARCHEAN

- Granite - tonalite, charnockite - enderbite (~2.54 Ga)
- Committee Belt; 2.9-2.5 Ga granite-greenstone terranes with some older and younger rocks, and Paleoproterozoic reworking
- Undifferentiated Archean (3.8-2.5 Ga); local Paleoproterozoic reworking
- NP = Nain Province, SP = Superior Province, and QM = Queen Maud Block

MAJOR PALEOPROTEROZOIC STRUCTURES:

- thrust
- western limit of Northeast Baffin Thrust Belt (1.825-1.81 Ga)
Fig. 2. Geology of northern Baffin Island; BB: Bylot Batholith, CBF: Central Borden fault zone, IF: Isortoq fault zone, PF: Piling fault zone.
xenocrysts in syenite (Ashton 1988), ca. 3.0–2.81 Ga detrital zircon in quartzite near Woodburn Lake (Davis & Zaleski 1998), and by ca. 2.84 zircon in conglomerate on northwestern Baffin Island at Eqe Bay (Bethune & Scammell 1997).

The middle episode, at ca. 2.76–2.71 Ga, is represented by widespread felsic plutonism and by metavolcanic and paragneiss sequences, such as the Woodburn Lake, Ketyet River, Prince Albert and Mary River groups (Fig. 1) that occur in NE–SW-trending belts that are complexly deformed with large-scale fold hinges tens of km across (e.g., Fig. 114 in Jackson 2000, and references therein). Younger granitic plutons and orthogneisses, most in the range ca. 2.6–2.5 Ga, have been reported, mostly from the southwestern part of the belt from Boothia Peninsula to south of Baker Lake (Fig. 1; Dudás et al. 1991, LeCheminant & Roddick 1991, Frisch & Parrish 1992, Davis & Zaleski 1998), but they also are present on southern Devon Island, Bylot Island, and in northwestern Greenland.

A ca. 2.55–2.5 Ga tectonothermal event may have affected much of the Committee belt. Evidence for this event comes from ca. 2.54 Ga SHRIMP analyses of zircon (likely igneous) of the charnockite Bylot Batholith on northwestern Baffin Island (D.J. Scott & G.D Jackson, unpubl. data), ca. 2.52–2.43 Ga orthogneisses on southern Devon Island (Frisch 1988), and ca. 2.56–2.5 Ga zircon and monazite inclusions in garnet from middle- to upper-amphibolite-facies metapelites just south of Baker Lake (Stern & Berman 2000).

The extent and boundaries of the Committee belt are uncertain, given the reconnaissance nature of geological information within the belt. Although the Isortoq fault zone (IF) and its southwestward extension are taken as the southern boundary of the Committee belt with the Baffin orogen, the occurrence of reworked Archean rocks south of the IF indicates that the Committee belt was more extensive than shown in Figure 1. Its northwestern border has been taken tentatively as the northeastern Queen Maud Block to include it in the Committee belt at this time. Extension of the Committee belt into the Inglefield Bredning – Melville Bugt (IB) region of northwestern Greenland (Fig. 1) is based on the lithological, geochronological, and metamorphic similarities between supracrustal rocks there (Dawes & Frisch 1981, Nutman 1984, Dawes et al. 1988, Dawes 1991) and the Mary River Group on Baffin Island (Fig. 1). An extension of the Thelon Tectonic Zone may truncate the Committee belt west of northeastern Greenland (e.g., Condie & Rosen 1994, Kalsbeek et al. 1993). Within the Committee belt on northern Baffin Island, four major assemblages of rocks have been identified (Fig. 2) and are described below. The Mesoarchean (<2.9–2.8 Ga) is represented by felsic orthogneisses and by foliated, strongly deformed felsic plutonic rocks. Neoarchean (2.76–2.71 Ga) rocks include the supracrustal Mary River Group and post-Mary River Group, syn- to late-tectonic felsic intrusions. Because of Paleoproterozoic deformation, metamorphism, and plutonism, two map units are of uncertain age (Archean or Paleoproterozoic or both): layered gneissic migmatisite, and granite – charnockite. The Paleoproterozoic Piling Group (see Baffin orogen below) was deposited on the exhumed Archean complex. A subsequent exhumation after Paleoproterozoic orogenesis was followed by deposition of the Mesoproterozoic Bylot Supergroup in the Borden Rift Basin (Fig. 3).

**Mesoarchean rocks**

The oldest rocks occur in a basement complex that consists predominantly of nebulitic and migmatic granitic–tonalitic orthogneisses, together with undifferentiated, relatively small, less deformed, younger felsic plutons, and variable gneisses of uncertain origin. Foliated and deformed monzogranite–tonalite plutons also form part of the basement complex (Fig. 2), and are closely associated with the more highly deformed nebulitic gneisses. Field relationships indicate that the foliated plutons intrude nebulites, a relation that is compatible with Nd model ages: model ages of nebulite attain 3.7 Ga and are all older (mean 3.3 Ga: Hegner & Jackson 1990, Jackson & Hegner 1991) than those for foliated felsic intrusions (mean 2.8 Ga). Although these ages may reflect different amounts of incorporated protolith (>2.8 Ga) in the two units, similar U–Pb zircon and Nd model ages of 2.85 and 2.84 Ga for samples of foliated granite (Hegner & Jackson 1990, Jackson et al. 1990b, Bethune & Scammell 1997) indicate that at least some foliated granitic rocks are composed mostly of juvenile material. Two ca. 2.78 Ga ages of crystallization of felsic gneisses at Eqe Bay, based on zircon (Bethune & Scammell 1997), suggest early Neoarchean reworking. The younger Mary River Group (see Neoarchean below) unconformably overlies the complex in several places, and is also locally in fault contact with scattered remnants of metasedimentary and metavolcanic rocks within the complex (Jackson 2000). Differences in composition between Mary River amphibolites and some of these metavolcanic rocks (e.g., areas A and B, Fig. 3; Jackson 1978b, 2000) are consistent with the interpretation that some of these supracrustal remnants within the basement complex predate the Mary River Group.
Neoarchean

Rocks assigned to the Mary River Group (MRG) are generally a minor bedrock component that forms lenticular bodies as much as 65 km long, generally preserved throughout the Committee belt as inffolds and isolated remnants within older gneiss and within migmatite derived from the MRG (Figs. 2, 3). The Mary River Group most commonly consists of a lower sequence of metamorphosed, bimodal (calc-alkaline and felsic to tholeiitic mafic and ultramafic, including spinifex-bearing komatiite) metavolcanic rocks and an upper sequence of pelite—greywacke of turbiditic affinity. The stratigraphic positions of chromian-muscovite-bearing quartzite, conglomerate, volcanic breccia, Algoma-type iron formation (containing some of the highest-grade primary and secondary iron deposits in the world), and minor marble vary on a regional scale (Jackson 1966, 2000, Morgan et al. 1975, Bethune & Scammell 1997). Mafic and ultramafic intrusions are abundant; anorthosite occurs locally. U–Pb zircon ages for felsic metavolcanic rocks (Morgan 1982, Jackson et al. 1990b, Jackson et al. 1990a, Bethune and Scammell 1997) indicate extrusion ages of 2.76–2.72 Ga. Mafic metavolcanic rocks are likely of similar age, given that they both underlie and overlie felsic volcanic rocks at different localities. Similar ca. 2.85 Ga Nd model ages have been obtained for two mafic metavolcanic samples and a 2.85 Ga (zircon) basement tonalite sample (Hegner & Jackson 1990, Jackson et al. 1990a). Deposition of the group is interpreted to be related to rifting in a large, unstable, volcanically active basin. The chemical composition of Archean granitic rocks (G.D. Jackson, unpubl. data) favors emplacement in a volcanic arc environment of an active continental margin (Jackson 2000), although field and Sm–Nd data suggest that some Neoarchean chemical signatures may have been inherited from a remelted Mesoarchean protolith.

A large number of syn- to late-tectonic, massive to weakly foliated, near-minimum-melt-granite intrusions appear to truncate Mesoarchean rocks and the Mary River Group. Regionally, most of these intrusions are K-feldspar-phryic monzogranite–granodiorite (Fig. 2), but at Mary River (Jackson 1966) and Eqe Bay (Bethune & Scammell 1997), felsic intrusive rocks are equigranular and have a wider compositional range. Ages of crystallization based on zircon are 2.73–2.70 Ga, as little as 9 Ma younger than Mary River metavolcanic rocks they intrude. A Nd model age for one sample suggests that these intrusive rocks may contain a component at least as old as 2.90 Ga (Hegner & Jackson 1990, Jackson et al. 1990a, b).

Archean – Paleoproterozoic

Layered migmatite and gneiss comprise a complex of variously intermixed and assimilated remnants of all Archean to middle Paleoproterozoic map units, including the Piling Group. Zircon ages for granitic components may range from 2.85 to 1.82 Ga. Most Nd model ages are 2.9–2.5 Ga (Hegner & Jackson 1990, Jackson et al. 1990a). The presence of low-grade strata of the Mary River Group unconformably overlying migmatite and other high-grade gneisses in a few localities indicates at least one episode of pre-MRG formation of migmatite.

Another melting event considered to be related to rereworking of the southern part of the Committee belt during the Baffin orogeny is indicated by the Proterozoic lower intercept of the U–Pb zircon data from an anatetic granite in migmatite southwest of Buchan Gulf. These data have been interpreted to indicate Proterozoic melt formed from an Archean protolith considered in part to be ca. 2.73 Ga amphibolite of the Mary River Group engulfed in this melt (Jackson et al. 1990b). The 2.522 ± 0.01 Ga upper intercept for this granite may represent an additional high-grade event recognized elsewhere in the Committee belt (see above).

Massive to weakly foliated felsic intrusions, commonly of near-minimum-melt monzogranite composition, occur throughout the Committee belt as locally abundant dykes, sills, stocks and as numerous batholiths (Fig. 2). The larger bodies are concentrated in two discontinuous belts that are discordant with regional structural and supracrustal trends in the Committee belt, although contacts of most individual plutons parallel local structures. Pink, equigranular granitic intrusions occur in a belt from Milne Inlet south past the western end of the Dexterity granulite belt (DBG). Equigranular to feldspar-phryic charnockite intrusions occur mostly within the Dexterity granulite belt (Figs. 1–3) and sporadically in the Northeast Baffin thrust belt. Pluton contacts are normally sharp at grades lower than granulite, but are commonly less distinct at granulite-facies conditions owing to metamorphic recrystallization.

With the following exceptions, the ages of most felsic intrusive bodies are constrained only to be younger than the Mary River Group and older than middle Paleoproterozoic. U–Pb data for a pluton of pink monzogranite west of Bylot Island suggest Paleoproterozoic melting and recrystallization of Archean protolith (Jackson et al. 1990b), and some felsic plutons interpreted as Archean adjacent to the Dexterity granulite belt appear to grade into charnockite within the Dexterity granulite belt. However, most charnockite within the Dexterity granulite belt is considered to be ca. 1.82 Ga, the age of granulite-facies metamorphism and deformation in the southwestern end of the Dexterity granulite belt (Bethune & Scammell 1997). Several syn- to late-kinematic granites in the Eqe Bay area also have ca. 1.82 Ga ages of crystallization (Bethune & Scammell 1995, 1997, Scammell & Bethune 1995). Mesoarchean, Neoarchean and Paleoproterozoic felsic plutons have similar Nd-depleted mantle model ages of 2.91–2.82 Ga (Hegner & Jackson 1990, Jackson et al. 1990a, Jackson & Hegner 1991), suggesting derivation from a common Archean crustal source.
**GEOLGY OF THE BAFFIN OROGEN**

The southern part of northern Baffin Island was strongly affected by the Middle Paleoproterozoic (ca. 1.87–1.81 Ga) tectonism and magmatism that forged the Baffin orogen (Fig. 1). The core of the orogen is the huge, triangular Cumberland Batholith, composed chiefly of anastomosing, variously deformed, orthopyroxene-bearing, mostly 1.87–1.85 Ga, chiefly of anastomosing, variously deformed, ortho-

The Cumberland Batholith is surrounded by three coeval fold-and-thrust belts: the Dorset fold-and-thrust belt to the southwest, the Nagsugtoaqidian mobile belt to the southeast and the Foxe fold-and-thrust belt to the north (Fig. 1). The latter extends from a strikingly complex fan fold (Henderson 1984) in southern Melville Peninsula eastward across central Baffin Island to its apparent termination in northwestern Greenland in another large-scale fold closure several tens of kilometers across (Escher 1985). The belts contain correlative, ca. 1.9 Ga supracrustal sequences (Hegner & Jackson 1990, Henderson & Parrish 1992, Scott & Gauthier 1996, Scott 1997, 1999), an uncertain amount of tec-

**Piling Group**

Archean rocks of the Committee belt predominate throughout the northern third of, and represent the base-

The Piling Group comprises a lower, thin shelf sequence of quartzite and marble conformably overlain by a thin, fysch-like turbidite sequence of greywacke, shale and metamorphosed equivalents that compositionally mature upward. Sulfide-bearing schist with iron formation and a discontinuous basalt – gabbro – ultramafic rock – iron formation unit occurs in the basal turbidites (e.g., Jackson & Taylor 1972, Morgan et al. 1975, 1976). The group has been traced southward well into the northern part of the Cumberland Batholith, and northward into the reworked southern part of the Commit-

**TECTONIC DOMAINS AND DOMAIN BOUNDARIES**

The Precambrian rocks of Baffin Island have been divided into eight tectonic domains, with additional subdomains, on the basis of differences between structural trends, aeromagnetic patterns, location of major
LEGEND

MID-MESOPROTEROZOIC

BORDEN RIFT BASIN (Tectonic domain 8, 1.27 Ga); Bylot Supergroup; sedimentary
and mafic volcanic rocks.

ARCHEAN-PALEOPROTEROZOIC

NORTHEAST BAFFIN THRUST BELT (Tectonic Domain 7, ~ 1.825-1.81 Ga);
Three subdivisions: 7a, 7b, 7c.

FOXE FOLD AND THRUST BELT (Tectonic Domain 3); Archean gneisses,
~1.9 Ga Piling Group; Three subdivisions: 3a, 3b, 3c (not shown).

COMMITTEE BELT (2.9-2.5 Ga?)

Chiefly Archean rocks (2.9-2.5 Ga?) and structures with varied
Paleoproterozoic structural and metamorphic overprinting.

TECTONIC DOMAIN 2 (Steensby Domain); Archean and ~ 1.9-1.825 Ga structures,
metamorphism present. Three subdivisions: 2a, 2b, 2c.

TECTONIC DOMAIN 1 (Mary River Domain); Mostly Archean structures; Archean and Paleoproterozoic
metamorphism. Two subdivisions: 1a, 1b.

MARY RIVER GROUP (2.76-2.72 Ga); supracrustal belts (Fa, Fb) south of Isortoq Fault (IF).

METAMORPHIC ZONES

Subgreenschist stratigraphically up to unmetamorphosed

Greenschist

Greenschist- lower amphibolite

Lower amphibolite

Chiefly upper amphibolite

Granulite: Paleoproterozoic (may include Archean); Dexterity Granulite Belt (1.825 Ga)

Granulite: Bylot Batholith (ca. 2.54 Ga)

FIG. 3. Tectonic domains, regional distribution of metamorphic zones and thermobarometry results for the Precambrian of
northern Baffin Island.
faults, proportions of major rock-types and available geochronology (Jackson 2000). Most boundaries between domains and subdomains are either known or interpreted faults (Fig. 3). Table 1 summarizes the main characteristics of, and differences between, tectonic domains and subdomains within northern Baffin Island. Domains 1, 2, and subdomain 7a occur within the Archean Committee belt; domains 3–6 and subdomains 7b and 7c are within the Paleoproterozoic Baffin orogen, but domains 4–6 and most of subdomain 7c are further south than the area shown in Figure 3. The Northeast Baffin thrust belt overprints domains 1–3 and subdomains 5a and 6a, and thus comprises a part of both the Committee belt and Baffin orogen. Tectonic domain 8, the Mesoproterozoic Borden Rift Basin, consists mostly of sedimentary rocks (Jackson & Iannelli 1981, Iannelli 1992).

Within the Committee belt, the main difference between domains 1 and 2 is the degree to which Archean structures are preserved. Domain 1 has variable structural trends, considered to be Archean in age, with early structures refolded about east- and southeast-trending axes. Southeast-trending structural and aeromagnetic fabrics become dominant in subdomain 2c and may include a Paleoproterozoic straightening component. North-dipping, dominantly E-trending foliations, with NE-plunging lineation, suggest east-directed thrusting; boundary with 2b is sharp in the northeast (Jone et al. 1993, Iannelli 1992, Jackson & Iannelli 1981).

The boundary between tectonic domains 2 and 3, and between the Committee belt and Baffin orogen, is the Isortoq fault zone (IF), which continues southwest to Melville Peninsula (Fig. 1), where it is cut off by the ca. 1.82 Ga Ford Lake plutons (LeCheminant et al. 1987). On Baffin Island, the Isortoq fault zone separates the Dexterity granulite belt to the north from amphibolite-facies rocks to the south. Northeast of the Barnes Ice Cap, foliations are variable, and the diffuse aeromagnetic change across the fault zone suggests a moderate dip (P. McGrath, pers. commun., 1990). At one locality, near Eqe Bay, the Isortoq fault zone includes a ~50-meter-wide mylonite zone that dips 50° SE, which is consistent with inferences based on the sharp change in aeromagnetic pattern across the fault southwest of the Barnes Ice Cap. Sinistral kinematics, together with a 35° east-plunging extensional lineation, indicate that latest movement involved uplift of the high-grade northwest block obliquely toward the west.
Observations summarized below suggest that the early history of the Isortoq fault zone involved northwest-orientation thrusting along the Isortoq fault zone at low angle (Fig. 2; see also Jackson et al. 1978). We interpret this fold to have originated during early northwest-directed, oblique dextral thrusting along the Isortoq fault zone, in which E–W structures were truncated and dragged southwestward. Bethune & Scammell (1995, 1997) also interpreted the fault zone to have an early history of northwest-directed thrusting, partly on the basis of increased flattening and northwestward overturning of northeast-trending folds (Morgan 1982) as the fault zone is approached from the south. Further east within tectonic domain 3a, northeast of the Barnes Ice Cap and near the head of Gibbs Fiord, northeast-trending, southeast-dipping planar structures adjacent to the Isortoq fault zone also are interpreted as northwest-directed thrusts (Jackson & Morgan 1978b, Jackson 2000).

On a regional scale, structural trends are northeastly within tectonic domain 3, the Foxe fold-and-thrust belt. Although two phases of Archean deformation have been recognized, most deformation (four phases) is Paleoproterozoic (Morgan et al. 1976, Tippett 1980, Henderson et al. 1989). The most northerly subdomain (3a) consists mostly of Archean rocks with more variable trends than other subdomains, and some Archean-cored domes. Subdomain 3b is characterized by upright to variably inclined, near-isoclinal folding of the low-grade Piling Group. The latter grades southward into subdomain 3c, which consists of upper-amphibolite-facies Piling strata, satellite plutons of the Cumberland Batholith, and some Archean-cored structural domes.

The Piling fault zone (PF, Fig. 3) separates subdomains 3a and 7b to the north, with variable structural trends, from subdomains 3b and 7c to the south, in which structural trends parallel the fault. Faults and lineaments mapped along the fault zone are parallel to it and coincide with aeromagnetic anomalies, suggesting that the western end of the fault zone may be a broad (up to 5 km wide) shear zone, whereas the eastern part may be a relatively narrow fault-zone (Morgan 1983, Henderson 1985a, G.D. Jackson, unpubl. data). Nappes, which are subhorizontal, apparently north-verging thrust slices of Paleoproterozoic Piling Group and domes cored by Archean basement, occur mostly north of the Piling fault zone (Fig. 2; Jackson 1978a). In contrast, the south side of the Piling fault zone is characterized by steeply dipping limbs of gently to steeply plunging parallel folds of Piling meta-turbidite with few basement gneiss domes. Like the Isortoq fault zone to the north, the latest movement was south side down.

The Northeast Baffin thrust belt (NBTB, domain 7) contains the same lithologies as western domains, including the Mary River Group and the Paleoproterozoic Piling Group. Southeastern structural trends predominate in most of this domain, but are less evident in the middle subdomain (7b). Subdomain 7a is also characterized by stacks of southwest-directed, gently northeast-dipping, dextral thrust-slices and isoclinal nappes with attenuated fold limbs more than 10 km long (Figs. 4–7). Pronounced straightening is especially evident along the western side of subdomain 7a, where the Northeast Baffin thrust belt truncates domains 1 and 2, and overprints the Foxe fold-and-thrust belt (domain 3). The orientation of small felsic plutons and Mary River Group remnants parallel to the axis of the Northeast Baffin thrust belt, an apparent truncation of northeast-trending Piling Group fold keels east of the Barnes Ice Cap by southwest-directed thrusts (e.g., Kranck 1955, Jackson 2000), and interference folds (Figs. 1–3) indicate that late deformation in the Northeast Baffin thrust belt is younger than that in adjacent tectonic domains. A little-deformed, 1.806 ± 0.01 Ga tonalite pegmatite in the Home Bay region in northern subdomain 7c has been interpreted to postdate this deformation (Henderson & Loveridge 1981). The maximum age of the thrust belt is considered to be no older than the 1.825 Ga granulite-facies metamorphism in the east end of the Dexterity granulite belt, which is interpreted to be overprinted, mostly at upper-amphibolite-facies conditions, by southwestward-locally southwesterly, forming the general westerly to southwesterly direction of ductile thrusting and nappes movement and their likely pre-Cretaceous drift proximity, suggest that the Northeast Baffin thrust belt may represent the southwestern extension of the latest Paleoproterozoic deformation in the Rinkian belt on west Greenland (Fig. 1; Kalsbeek 1986, Grocott & Pulvertaft 1990).

Two middle to late Mesoproterozoic supracrustal basins (domain 8) include the Borden Rift Basin (Fig. 3) and the Fury and Hecla Basin (Fig. 2). The Borden Rift Basin contains rocks of the Bylot Supergroup, with a maximum preserved thickness of ~6 km, and represents an aulacogen (Olson 1977) that developed from about 1.27 to 1.19 Ga during the opening, and possible subsequent closing, of the Poseidon Ocean to the northwest. Using aeromagnetic data, faults can be traced another 150 km southeast from the last exposures of strata of the Bylot Supergroup (Fig. 3). Some of the main Mesoproterozoic faults, such as the Central Borden fault zone (Fig. 3), have been active intermittently up to Recent time along a distance of 1200 km from Cornwallis Island southeast to the east coast of central Baffin Island (Jackson & Iannelli 1981, Knight & Jackson 1994).
Fig. 4. View looking northwest at recumbent folds in Archean–Paleoproterozoic migmatite ~60 km northwest of Buchan Gulf. Rocks contain deformed mafic bands (dykes?) and near-vertical mafic dykes which are locally beaded (e.g., left of snow in crevice). The folds are truncated by a horizontal zone of “straight gneiss” interpreted as a ductile thrust zone. The shear zone dips northward under an antiformal fold overturned to the south at the right of the photo. Relief ~900 m. GSC photograph 186330, by W.J. Crawford.

Fig. 5. View looking northwest at sinistrally sheared, southwest-verging ductile nappe of Archean–Paleoproterozoic migmatite, overlying Archean nebulitic gneiss (southeast side of Scott Island north of Buchan Gulf). Elevation ~460 m. GSC photo 158677, by S.L. Blusson.

REGIONAL METAMORPHISM

Age constraints

Current geochronological data for igneous and metamorphic rocks of northern Baffin Island indicate four main tectonometamorphic episodes at ca. 2.9–2.84, 2.76–2.71, 2.6–2.5 and 1.9–1.8 Ga. Subgreenschist-facies metamorphism also affected at least parts of the region between ca. 1.3 and 0.7 Ga. At present, the scant geochronological database does not allow the areal extent of the various Archean events to be delineated within the Committee belt. Whereas the available data suggest that the entire belt was likely affected by ca. 2.7 Ga metamorphism, further work is needed to identify the extent of the ca. 2.85 and 2.55 Ga events. Data
summarized below suggest that metamorphism associated with formation of the Baffin orogen affected most parts of northern Baffin Island.

Available geochronological data for the Foxe fold-and-thrust belt indicate metamorphism between ca. 1.85 and 1.81 Ga. In one area in southern tectonic subdomain 3c, ca. 1.81 Ga monazite has been interpreted to date the deformation (Henderson & Henderson 1994). In another area, ca. 1.85 Ga charnockite that intrudes middle- to upper-amphibolite-facies rocks of the Piling Group contains ca. 1.83 Ga monazite grains (Jackson et al. 1990b). Further north, in the Eqe Bay region of tectonic domain 3a, metamorphism is dated by ca. 1.845 Ga zircon in amphibolite of the Mary River Group, as well as 1.83–1.82 Ga zircon, monazite and titanite in charnockite, MRG amphibolite and MRG and Piling

Fig. 6. View looking southeast at isoclinal recumbent folds in Archean–Paleoproterozoic migmatite with amphibolite layers in the western Buchan Gulf region. Elevation several hundred m. GSC photo 204194–H, by A. Davidson.

Fig. 7. View looking southwest at isoclinal recumbent fold with an east–west-trending axis in Archean–Paleoproterozoic migmatite, south side of lower McBeth Fiord. The migmatite includes plastically deformed paragneiss, amphibolite and granitic layers, and locally boudined amphibolite. Height of cliff ~450–600 m. GSC photo 185945, by S.L. Blusson.
Group metapelites (Bethune & Scammell 1997). Similar ages of peak metamorphism have been obtained both north of the Isortoq fault zone in tectonic domain 2c, within the Dexterity granulite belt (ca. 1.83–1.82 Ga zircon and monazite; Bethune & Scammell 1997), and in southern Baffin Island (ca. 1.85–1.84 Ga; Scott 1997), indicating that metamorphism was broadly synchronous throughout much of the Baffin orogen. Cooling ages compatible with this age of peak metamorphism have been obtained for charnockite in subdomain 3c (1.73 Ga Rb–Sr isochron; 1.73–1.69 Ga biotite K–Ar) and Archean granitic basement in subdomain 3c (1.64–1.59 Ga Rb–Sr and muscovite K–Ar; Henderson 1985b, Jackson et al. 1990b).

Given the widespread evidence for Paleoproterozoic metamorphism, an important question that remains is the degree to which Archean mineral assemblages are preserved in northern Baffin Island. The best documentation of preserved Archean assemblages of metamorphic minerals is provided by Bethune & Scammell (1997) for rocks of the Mary River Group with ca. 2.76–2.72 Ga ages of igneous crystallization in the Eqe Bay region (Figs. 2, 3). Their data suggest that rocks in the Eqe Bay belt (Fa, Fig. 3) and southeastern part of the Isortoq belt (Fb) were metamorphosed to greenschist to middle amphibolite facies at ca. 2.72 Ga before being reworked at greenschist-facies conditions at ca. 1.82 Ga. Titanite in some dated lithologies retains ca. 2.7 Ga ages, in marked contrast to ca. 1.82 Ga metamorphic titanite in felsic gneiss and pegmatite just north of the Isortoq fault zone. A Rb–Sr errorchron age of ca. 2.2 Ga for metavolcanic rocks in the Eqe Bay Belt (Morgan 1982) likely represents an Archean age that was partially reset during ca. 1.82 Ga low-grade metamorphism.

North of the Isortoq fault zone, available geochronological data are not conclusive, but suggest decreasing Paleoproterozoic reworking northward from the Dexterity granulite belt, a pattern that is consistent with the inferred tectonometamorphic evolution discussed below. In the Mary River area of tectonic subdomain 1a (Figs. 2, 3), the Mary River Group yields a ca. 1.97 Ga Rb–Sr isochron. These data, together with metamorphic overprinting textures described below, are interpreted to indicate moderate resetting of Archean metamorphic assemblages during Paleoproterozoic lower- to middle-amphibolite-facies metamorphism. Further north in the westernmost part of tectonic subdomain 7a, Archean gneisses east of Admiralty Inlet give a ca. 2.3 Ga Rb–Sr errorchron (Jackson et al. 1990b). We tentatively relate these ages to minor resetting during ca. 1.83 Ga subgreenschist- to greenschist-facies metamorphism, an interpretation supported by the otherwise anomalously high P–T conditions recorded by one sample in this area (see below). A 1.1 Ga Rb–Sr age for amphibolite-facies mafic–ultramafic dykes within the above gneiss may have resulted from fluid-enhanced resetting during Mesoproterozoic low-grade metamorphism. The overall interpretation of the Admiralty Inlet area needs to be further tested, as other locations north and south of the Isortoq fault zone (basement gneiss to the Mary River Group at Mary River, and upper-amphibolite-facies granitic gneiss and plutons north of the Piling fault zone) preserve Archean (2.7–2.5 Ga) and middle Paleoproterozoic (ca. 2.1) Ga whole-rock Rb–Sr isochrons (Jackson 1978a, b, 2000), whereas supracrustal rocks yield Proterozoic (2.0–1.9 Ga) Rb–Sr isochrons. These differences in Rb–Sr ages in felsic gneiss and plutons and supracrustal rocks may be explained by contrasting permeability of the rocks and associated fluid-enhanced recrystallization, which exerted a major control on isotopic resetting.

Most metamorphic assemblages in the Northeast Baffin thrust belt are considered to be Paleoproterozoic because the belt transects tectonic domains to the west and deforms rocks in the eastern part of the belt, the Foxe fold-and-thrust belt, and the Cumberland Batholith (Figs. 1, 3; Jackson 1998, 2000). In addition, the belt has yielded several K–Ar ages, most between 1.70 and 1.63 Ga. The preliminary age of ca. 2.54 Ga obtained for zircon in sheared endebrite in the western arm of the Bylot Batholith (Figs. 2, 3) is interpreted as the time of igneous crystallization. Although emplacement of the batholith was likely associated with granite-facies metamorphism in surrounding rocks, similarity in structural fabric with more southerly portions of the Northeast Baffin thrust belt suggests that this part of the belt was also involved in the same Proterozoic tectonometamorphic event. Zircon samples from two other samples in the thrust belt, one from south of Buchan Gulf and the other west of Bylot Island, yield upper intercept ages of ca. 2.52 and 2.50 Ga and poorly constrained lower intercept ages of ca. 1.53 and 1.52 Ga. These data have been interpreted to result from mixed populations of Archean and Proterozoic zircon formed during ca. 1.8 Ga melting of Archean crust (Jackson et al. 1990b).

Regional distribution of metamorphic zones

Assemblages of metamorphic minerals are listed in Jackson & Morgan (1978a), Bethune & Scammell (1997), and Jackson (2000) and, for the most part, are not repeated here. The general distribution of metamorphic facies is shown in Figure 3 (for more details, see Fraser et al. 1978, R.G. Berman, in prep.). With the exception of lower- to middle-amphibolite-facies rocks in the southern greenstone belt at Eqe Bay (Fa, Fig. 3) and greenschist-facies rocks at Mary River, all facies boundaries are considered to be Proterozoic in age, as discussed above.

Granulite-facies rocks are most abundant in the Paleoproterozoic Dexterity granulite belt and in the northwestern part of the Northeast Baffin thrust belt. The Dexterity granulite belt extends about 280 km southwest–northeast across Baffin Island, past the north
The granulite belt contains three segments, separated by irregular, south-east-striking, lower-grade Middle Paleoproterozoic tectonic zones, Mesoproterozoic–Recent faults, and Neoproterozoic dyke swarms. Metamorphic contrasts within the belt and between the belt and rocks to the northwest seem to be gradational. Field data and geochronology indicate that garnet amphibolite facies within the belt include both older Archean granites metamorphosed to granulite facies as well as symmetamorphic intrusions (Jackson & Morgan 1978a, Bethune & Scammell 1997, Jackson 2000).

The second largest region of granulites occupies a huge, complex, synformal structure cored by the U-shaped, ca. 2.54 Ga monzocharnockitic Bylot Batholith (BB on Fig. 3), which is most strongly deformed along its western arm. An area of upper amphibolite-facies rocks lies along the synformal axis northwest of the nose of the structure. Lineations plunge ~20°NW in the core and east limb of the batholith, but are more variable west of the fold axis, plunging shallowly northwest parallel to the western contact.

The Opx-in isograd that bounds granulite-facies rocks in the larger regions commonly transgresses, but in some places is parallel to map units and structural trends, indicating that at least some granulite-facies metamorphism postdates the main episode of deformation. Some plutons, such as the Bylot and Dexterity batholiths (Fig. 2) and a small granite–charnockite pluton east of the Barnes Ice Cap, are partially to completely rimmed by relatively narrow bands of amphibolite-facies country rocks, suggesting that the plutons were a significant source of heat for high-grade metamorphism. In other places, the Opx-in isograd cuts across granitic plutons, indicating metamorphism after pluton emplacement. Bethune & Scammell (1997) documented a steep Proterozoic metamorphic gradient going southward from the Dexterity granulite belt to greenschist-facies assemblages in the Eqe Bay region (Fig. 3). The gradient northward from the Dexterity granulite belt to greenschist-facies assemblages at Mary River is much more gradual. The lack of evidence of significant retrogression across this metamorphic transition suggests that it is a prograde, Proterozoic, feature.

The most common granulite-facies assemblages include quartz, plagioclase, biotite, orthopyroxene, clinopyroxene, brown-green hornblende and pyrope-rich garnet. Although compatible on an outcrop scale, orthopyroxene and sillimanite have not been found to coexist within the same thin section. Minor development of retrograde minerals is widespread and not systematically distributed, suggesting that it is a local result during the waning stages of metamorphism, rather than a consequence of later regional amphibolite-facies retrogression. Partial retrogression due to fluid ingress is common along faults, shear zones, and lineaments.

Most of northern Baffin Island consists of upper-amphibolite-facies quartzo-feldspathic gneissic rocks without diagnostic mineral assemblages, but they and associated supracrustal rocks show a variety of textures indicative of extensive partial melting. Some migmatite, including some derived from Mary River Group strata, formed during at least two episodes of partial melting. Retrogression from granulite facies has only been observed locally.

The largest area of greenschist- to middle-amphibolite-facies rocks occurs in the Paleoproterozoic Piling Group in the central part of the Foxe fold-and-thrust belt (Fig. 3). The other main areas of greenschist-facies rocks are in the vicinity of Eqe Bay and in the Mary River area, both of which are commonly surrounded by thin lower- to middle-amphibolite-facies zones. As discussed above, mostly greenschist-facies assemblages of Archean age at both locations are considered to be overprinted by Proterozoic, greenschist- to lower-amphibolite-facies metamorphism.

The Nauyat volcanic suite (ca. 1.27 Ga) in the basal part of the Mesoproterozoic Bylot Supergroup strata in northwestern Baffin Island contains prehnite–pumpellyite assemblages indicative of subgreenschist-facies burial metamorphism. This assemblage has been observed in only one Franklin dyke (ca. 720 Ma; Pehrsson & Buchan 1999) in Borden Basin. The general absence of this assemblage in Franklin dykes throughout northwestern Baffin Island, and the relative paucity of alteration in them, compared with the older Nauyat volcanic rocks, bracket the age of subgreenschist metamorphism between 1.27 and 0.72 Ga (Fahrig et al. 1981, Jackson & Iannelli 1981, Pehrsson & Buchan 1999). Prehnite–pumpellyite assemblages that occur locally in metasedimentary rocks of the Mary River Group near Mary River (area A in Fig. 3) are assumed to be of the same age.

**REGIONAL PRESSURE – TEMPERATURE CONDITIONS**

*Methods*

Metamorphic pressures and temperatures have been determined for 26 samples from northern Baffin Island, mostly from pelitic metasedimentary rocks, amphibolite and orthopyroxene-bearing rocks in tectonic domains 1–3, and 7. All results were calculated with the TWQ computer program (Berman 1991) using the version 1.02 database that provides P–T estimates based on amphibole compositions (Mäder et al. 1994). For samples lacking garnet, temperatures were calculated with the hornblende–plagioclase thermometer of Holland & Blundy (1994) and the two-feldspar thermometer of Furhman & Lindsley (1988). For orthopyroxene-bearing assemblages, temperatures estimates were based on the Al content of orthopyroxene in equilibrium with garnet (Aranovich & Berman 1997; TWQ version 2.02). An important advantage of this Al-in-Opx thermometer is that it has been shown to be less prone to retrograde re-equilibration than typical
Fe–Mg exchange thermometers (Pattison & Bégin 1994, Berman & Bostock 1997).

Mineral analyses were performed on standard polished thin sections with a Cameca SX–50 electron microprobe equipped with four wavelength-dispersion spectrometers. The microprobe was operated at 15 kV with beam current of 10 or 30 nA depending on the element, sample stability and size. The raw counts were corrected to elemental concentrations using the Cameca “PAP” program (Pouchou & Pichoir 1985).

Thermobarometric data are complemented by P–T estimates for nine areas of metasedimentary rocks of the Mary River and Piling groups (Fig. 3: A–I) using constraints from a petrogenetic grid for pelitic rocks constructed by D.M. Carmichael (Davidson et al. 1990), with superimposed reactions involving calcic minerals from Froese (1997).

**RESULTS**

The regional distribution of P–T data is shown in Figure 3. Computed pressures and temperatures, along with mineral assemblages for each sample, are presented in Table 2. Mineral compositions used to calculate P–T values are given in Tables 3–6, which are available from the Depository of Unpublished Data, CISTI, National Research Council, Ottawa, Ontario K1A 0S2, Canada. The minerals in most samples show limited compositional variation: <5 mol% An in plagioclase, <0.05 Fe/(Fe + Mg) in biotite, garnet, and orthopyroxene. Almost all of the variation in Fe/(Fe + Mg) is related to retrograde re-equilibration, with the highest values in garnet and the lowest values in orthopyroxene and biotite occurring at mutual grain-boundaries, and intermediate values occurring at rims not in contact with another ferromagnesian phase.

**Tectonic subdomain 1a**

No thermobarometric data were obtained for subdomain 1a, and available constraints come from consideration of the petrogenetic grid. Mary River Group (MRG) metapelitic rocks in a ~40 km² area (A in Fig. 3) contain muscovite, staurolite, and rutile, in addition to all three aluminosilicate “polymorphs”. An early (assumed to be Archean), higher-pressure event is suggested by texturally early porphyroblasts of kyanitenow to 1 cm long. In places, the kyanite is almost entirely surrounded by cordierite, which is itself intergrown with andalusite. In other places, small porphyroblasts of staurolite partially rim kyanite, and aligned laths of sillimanite overgrow kyanite and andalusite. Given the Rb–Sr evidence cited above for Paleoproterozoic reworking in this area, these later-formed minerals are interpreted to have grown during the ca. 1.82 Ga low-pressure metamorphic event, culminating at roughly 4.0 kbar and 580°C. Although textural relations are not as clear, the occurrence of anthophyllite + sillimanite in MRG semi-pelite within other ~20–40 km² areas (B, C, Fig. 3) is also consistent with an early high-pressure event, followed by a lower-pressure event in which staurolite + muscovite ± andalusite grew. In areas labeled D (Fig. 3), similar low-pressure conditions, ~4.0 kbar and 580°C, are indicated by the assemblage Bt–Ms–Crd–And, with late needles of sillimanite marginal to the andalusite. In the southern area D, evidence of partial melting in pelitic metasedimentary rocks indicates that temperatures locally exceeded ~650°C.

**Tectonic subdomain 2a**

Pelitic mineral assemblages of the Mary River group, considered to have recrystallized during the Paleoproterozoic, occupy ~25 km² areas in central subdomain 2a (E, Fig. 3). The presence of muscovite, sillimanite, and anatectic melt indicate P–T conditions of ~4–7 kbar and 650°C, in agreement with two thermobarometric determinations, 6.1 kbar – 650°C and 5.4 kbar – 690°C (13, 14, Fig. 3).

**Dexterity granulite belt (tectonic subdomains 2a–c)**

Although the assemblage orthopyroxene + sillimanite + quartz has been observed in outcrop, its...
absence in thin sections of pelitic rocks suggests that the ca. 1.825 Ga Dexterity granulite belt formed at pressures below ~9.0 kbar (at 850°C; Aranovich & Berman 1996). Three samples (15–17, Fig. 3, Table 2) from within the central block of the Dexterity granulite belt yield P–T values just about at this upper limit, between 8.6 and 9.0 kbar, and between 710 and 760°C. The occurrence of magnesite spinel with quartz at locality H near the northwestern end of the Barnes Ice Cap (Fig. 3) suggests a somewhat higher grade of peak metamorphism in this region.

P–T determinations for four samples from the southwestern block of the Dexterity granulite belt (18–19, 24–25 in domain 2c) cluster between 8.0 and 8.8 kbar and between 760 and 845°C.

The Isortoq fault zone (IF)

The Isortoq fault zone separates the Dexterity granulite belt to the north from the lower-grade Eqe Bay block to the south (Fig. 3), several kilometers southeast of the location of sample 26 (Fig. 3). Upper-amphibolite-facies rocks border the mylonite in the fault zone at this locality, with granulite-facies rocks slightly farther to the northwest. Within the mylonite, porphyroclasts of garnet + clinopyroxene in a blastomylonitic matrix indicate a high-grade history, but most of the preserved assemblages equilibrated in the greenschist to lower amphibolite facies. P–T results for a cordierite–garnet-bearing sample of Piling Group paragneiss (#26) yield 4.9 kbar – 600°C, interpreted to represent a late stage of mylonite movement during uplift and cooling.

Northern tectonic subdomain 3a

The Eqe Bay area contains two main belts of Mary River Group rocks, the Eqe Bay belt (Fa) and the Isortoq belt (Fb; Fig. 3), with discontinuous extensions to the northeast and east of the northern end of the Barnes Ice Cap. A steep thermal gradient, accentuated by north-east-trending faults (Bethune & Scammell 1997), is indicated by a progression northwestward from ca. 2.72 Ga greenschist- to lower-amphibolite-facies assemblages in the southern part of belt Fb to ca. 1.83 Ga upper-amphibolite- and granulite-facies assemblages in the northern part of this belt. Within the southern belt (Fa), ca. 2.72 Ga metamorphic grade increases south-eastward from greenschist to amphibolite facies, with a greenschist-facies overprint at ca. 1.83 Ga (Morgan et al. 1975, Morgan 1982, Jackson & Morgan 1978a, Bethune & Scammell 1997). The presence of subgreenschist- to greenschist-facies, Meso–Neoproterozoic strata at Eqe Bay (Morgan et al. 1975) suggests that some of the late low-grade metamorphism is Meso- to Neoproterozoic.

The lack of observed kyanite in the Isortoq belt (Fb) provides a maximum pressure of ~6 kbar for muscovite-bearing rocks, and the presence of the assemblage Grt–Crd–Kfs–Sil in transitional granulite-facies rocks in the northern part of the belt (Bethune & Scammell 1997) also indicates relatively low-pressure conditions. Within the Eqe Bay belt (Fa), P–T results for sample #20 indicate 4.1 kbar – 640°C for what we assume (see above) are ca. 2.72 metamorphic conditions (Fig. 3), consistent with the commonly observed assemblage Crd + Grt + Sil. P–T results for another sample of Mary River Group paragneiss (#21), in the northeastern extension of Fa east of the Barnes Ice Cap, yield lower-grade conditions, 2.8 kbar – 605°C, which we tentatively assume to correspond to ca. 1.83 Ga metamorphic conditions. The presence of texturally early kyanite in this sample offers additional evidence for an earlier (assumed to be Archean), higher-pressure metamorphic event (see tectonic subdomain 1a above).

Southeastern tectonic subdomain 3a

Within area G at the southeastern corner of tectonic subdomain 3a (Fig. 3), Piling Group paragneiss with anthophyllite + sillimanite + muscovite and anatectic migmatite without staurolite constrain P–T conditions to approximately 6 kbar at 660°C. P–T results (#22, Table 2, Fig. 3) are 5.6 kbar – 685°C, in good agreement with constraints from the petrogenetic grid and with two-feldspar temperatures between 630 and 710°C. P–T results from Piling paragneiss further to the southeast (#23, Table 2, Fig. 3) are 5.8 kbar – 650°C, consistent with the presence of muscovite and the absence of staurolite.

Tectonic subdomains 7a, b: Northeast Baffin thrust belt

West of the southern end of Sam Ford Fiord, Piling Group paragneiss at location I (subdomain 7b, Fig. 3) contains the same assemblage as at location G, constraining P–T conditions to ~6 kbar – 660°C. Two-feldspar temperatures between 800 and 820°C suggest that conditions of peak metamorphism were higher and that muscovite in these rocks may be retrograde in origin.

Nearly all of the samples from the Dexterity granulite belt and to the north are either granulite-facies granitic plutons or metamorphosed mafic volcanic rocks. As discussed above, this northeastern block of the Dexterity granulite belt (Fig. 3) is considered to have been overprinted by the younger (1.825–1.81 Ga) Northeast Baffin thrust belt. Results obtained from this part of the Dexterity granulite belt yield consistently high pressures, between 9.7 and 10.7 kbar, and temperatures between 710 and 760°C for monzocharnockite (#10), syenocharnockite (#11), and felsic nebulitic gneiss (#12; older basement?). A similar high-pressure regime is indicated north of the Dexterity granulite belt from results for an upper-amphibolite-facies paragneiss sample (#9; 9.2 kbar – 765°C) from the Buchan Gulf area, an enderbitie (# 8; 11.8 – 725°C), and a Mary River Group metabasalt (#7; 9.7 kbar – 790°C).
On Bylot Island, near the northeastern end of the Northeast Baffin thrust belt, a sample (#2) of a syenocharnockite pluton west of the Bylot Batholith also yields high P–T conditions, 11.0 kbar – 830°C. Two samples of enderbite from the sheared western side of the Bylot Batholith (#4, 5) give distinctly lower pressures, between 6.0 kbar – 805°C and 8.3 kbar – 730°C; sample #5 contains ca. 2.54 Ga zircon, interpreted as the age of batholith emplacement. Pyrhotite, both within the western part of the Bylot Batholith (#3) and southeast of it (#6), also yield lower pressures, between 7.9 and 6.9 kbar, respectively (Fig. 3, Table 2).

Mixed gneisses on the east side of Admiralty Inlet at the location of sample #1 (Fig. 3, Table 2) are considered to lie on the southern side of tectonic subdomain 7a, rather than in northern subdomain 1a, because the dominant west–northwest structural trend in these gneisses parallels that in the Northeast Baffin thrust belt further east. In contrast, north–south trends are common in the gneisses in the south in subdomain 1a. The 2.3 Ga Pb–Sr isochron obtained in this area (see above) has been taken to indicate only minor Proterozoic reworking. Accordingly, we infer that thermobarometric results for this granulite-facies paragneiss (7.0 kbar – 800°C) correspond to Archean metamorphic conditions.

**Discussion**

Previous studies (Cortemiglia et al. 1985, Berman et al. 1993) of granulite-facies rocks within the Baffin orogen in south-central Baffin Island revealed a classic low P – high T metamorphic region (4.9 – 7.6 kbar; T up to 900°C), consistent with their evolution within the domain of the huge ca. 1.87–1.85 Ga charnockitic Cumberland Batholith. Similar pressures have been obtained within the Committee belt, mostly at upper-amphibolite-facies conditions, with the exception of granulite-facies rocks in the Bylot Batholith region (sample #3–6, Fig. 3), just east of Admiralty Inlet (sample #1, Fig. 3), and also on southern Devon Island (Frisch 1988). Extant geochronology suggests that the latter two samples reflect Archean (ca. 2.55 Ga?) metamorphic conditions, a possibility that cannot be ruled out for the Bylot Batholith region. All other granulite-facies rocks, both in the Dexterity granulite belt and in the eastern part of the Northeast Baffin thrust belt, record pressures above ~8.5 kbar. The geological setting of these samples suggests that Paleoarchean thermal evolution was controlled primarily by crustal thickening associated with northwest-directed overthrusting of tectonic domain 3a over 2c, and subsequent southwest-directed thrusting within the Northeast Baffin thrust belt.

The architecture of the southwestern part of this region appears to be a mirror image of that described for the southern portion of the Baffin orogen, in which a lower, northern Quebec plate has been underthrust by at least 160 km below an upper, Baffin Island plate containing the Cumberland Batholith (St-Onge et al. 1999, 2000). In northern Baffin Island, structural observations summarized above indicate that the Isortoq fault represents the most northerly major thrust-zone along which the Foxe fold-and-thrust belt was thrust northward over tectonic domain 2. Subsequent thermal relaxation in this intracratonic environment (Jackson et al. 1997) produced granulite-facies metamorphism within the tectonically thickened Dexterity granulite belt. P–T results within tectonic domains 1 and 2 offer strong support for this interpretation. Tectonic subdomain 1a, which extends to the west coast of northern Baffin Island, includes kyanite-bearing Archean rocks interpreted to have been increasingly reworked from north to south during the Baffin orogeny. Gneisses east of Admiralty Inlet that are inferred to retain Archean paleopressure (~7 kbar) represent the highest Paleoarchean crustal level (less than ~4 kbar recorded near Mary River). Southward toward the Isortoq fault, paleopressure and paleotemperature increase, from ~4–5 kbar in the southernmost part of tectonic subdomain 1a, ~5.5–6 kbar in subdomain 2a, to ~8.5–9.0 kbar over a broad region in tectonic domain 2c within the western portion of the Dexterity granulite belt. The discordance of the Opx-in isograd with tectonic structural offset of at least ~8 km. Compared to the higher crustal levels exposed in subdomains 1a and 2a, the broad area of 8.5–9.0 kbar granulite-facies rocks north of the fault suggests that gravitational forces likely induced differential uplift of the most overthickened region (Dexterity granulite belt). Late sinistral kinematics within the Isortoq fault zone are consistent with this uplift occurring during the extensional phase of the Baffin orogenic cycle, the maximum age of which is given by the youngest titanite (1.818 Ga) in the footwall of the fault zone (Bethune & Scammell 1997). Thus the Isortoq fault zone acted as an important structure not only during tectonic thickening, but also during extension and at least partial exhumation of the Dexterity granulite belt. Additional study of cooling ages on both sides of the Isortoq fault zone are needed in order to further constrain the complete history of uplift.

Differences in structural trends between the central and eastern parts of the Dexterity granulite belt are taken as evidence that the eastern end of that belt has been reworked within the Northeast Baffin thrust belt (see Tectonic Domains above). Approximately 2 kbar higher
pressure recorded at the eastern end of the granulite belt suggests that deformation associated with the Northeast Baffin thrust belt may have involved additional tectonic thickening. It should be noted, however, that about 0.6 kbar of the pressure contrast between the eastern and western ends of the Dexterity granulite belt (at sea level) may be accounted for by the Cenozoic uplift that has produced ~2 km of relief along the northeastern side of Baffin Island.

The Northeast Baffin thrust belt north of the Dexterity granulite belt (Fig. 3) also records high paleo-pressures (9.2–11.8 kbar) that are considered to be related to Paleoproterozoic crustal thickening. These pressures contrast markedly with the ~6–8 kbar pressures within and in the vicinity of the ca. 2.54 Ga Bylot Batholith. Southwest-verging nappes west of the batholith lie within a large arcuate, structurally complex region that rims the batholith to the south (Fig. 3). We suggest that the batholith is part of a thrust panel of Neoarchean rocks that was emplaced during the southwest-directed thrust imbrication characteristic of the Northeast Baffin thrust belt, and that contributed to tectonic loading of adjacent high-pressure rocks. Preservation of the Archean age of crystallization of the Bylot Batholith in a volcanic arc environment; associated low-pressure granulite-facies metamorphism at ca. 1.85–1.83 Ga.


6. Relatively high pressure, ca. 1.83–1.82 Ga granulite-facies metamorphism formed in the tectonically thickened, intracratonic Dexterity granulite belt, adjacent to the Isortoq fault zone.

7. Southwest-directed thrusting within the Northeast Baffin thrust belt (Jackson 2000) and the Rinkian belt in western Greenland (Grocott & Pulvertaft 1990), possibly related to a collision on the eastern side of Greenland; further tectonic thickening and higher pressure granulite-facies metamorphism in the Northeast Baffin thrust belt.

8. Exhumation and cooling, in part assisted by extensional movements along the Isortoq fault zone.

ACKNOWLEDGEMENTS

The authors are grateful to many people who provided assistance with this project. Drs. Vassily Kitsul and Sergey Bushmin, both of the Russian Academy of Sciences, kindly provided mineral compositions for four samples used in this study. Gordon Pringle spent considerable time in explaining the operation of his MINREP program, and Tom Frisch provided assistance in utilizing the TPF program of Dr. Fonorev. John Stirling carried out mineral analyses for about half of the 26 samples. Katherine Venance analyzed minerals in 11 samples, and assisted in performing TWQ calculations. Mary Clarke, Terry Houlan, Dana Kurfurst, Deborah Lemkow, Dianne Paul, Janet Tuffley, Lori Wilkinson, Chris Hemmingway, and Luc LePage assisted with drafting and the many modifications of Figures 1–3. The authors are very appreciative of the constructive reviews provided by K.A. Bethune, R.M. Easton, C.H. Jefferson, D. Scott, M. St-Onge, and T. Skulski.
REFERENCES


EVOLUTION OF NORTHERN BAFFIN ISLAND

---


Received December 23, 1999, revised manuscript accepted April 21, 2000.