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Authors' addresses

N. Wodicka ***(nwodicka@nrcan.gc.ca)***
Continental Geoscience Division
Geological Survey of Canada
601 Booth Street
Ottawa, Ontario K1A 0E8

M.R. St-Onge ***(mstonge@nrcan.gc.ca)***
D. Corrigan ***(dcorriga@nrcan.gc.ca)***
Continental Geoscience Division
Geological Survey of Canada
615 Booth Street
Ottawa, Ontario K1A 0E9

D.J. Scott ***(djscott@nrcan.gc.ca)***
Canada–Nunavut Geoscience Office
Geological Survey of Canada
626 Tumiit Building
P.O. Box 2319
Iqaluit, Nunavut X0A 0H0

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Preliminary report on the U-Pb geochronology of the northern margin of the Trans-Hudson Orogen, central Baffin Island, Nunavut

N. Wodicka, M.R. St-Onge, D.J. Scott, and D. Corrigan

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Abstract: A 2827 +8/–7 Ma age for a monzogranite represents the first confirmation that Archean crust forms the cores of antiformal culminations in the Dewar Lakes area, and is consistent with the suggestion that these culminations represent erosional windows exposing the southernmost edge of the Rae craton. A 2719 ± 4 Ma megacrystic monzogranite from the northern Archean basement is temporally and lithologically similar to ca. 2726–2714 Ma megacrystic granite bodies in the Eqe Bay area to the northwest. Uranium-lead dating of a biotite-allanite monzogranite reveals a Neoarchean emplacement age of 2738 +25/–21 Ma, suggesting that Paleoproterozoic plutonic rocks within the Archean basement in the Flint Lake area may not be as extensive as previously suspected. A crystallization age of 1897 +7/–4 Ma for a K-feldspar–megacrystic monzogranite, previously correlated with the mostly 1.87–1.85 Ga Cumberland batholith, indicates that psammite enclaves within the pluton must be older than ca. 1.90 Ga.

Résumé : Un âge de 2 827 +8/-7 Ma attribué à un monzogranite confirme pour la première fois l'existence de croûte archéenne dans les zones axiales de culminations antiformes dans la région des lacs Dewar et conforte l'hypothèse que ces culminations constituent des fenêtres d'érosion qui mettent à jour l'extrémité sud du craton de Rae. Un monzogranite à mégacristaux daté à 2 719 ± 4 Ma dans le socle archéen au nord est semblable sur les plans chronologique et lithologique aux amas de granite à mégacristaux datant d'environ 2 726 à 2 714 Ma qui sont présents dans la région de la baie Eqe, au nord-ouest. La datation par la méthode U-Pb d'un monzogranite à biotite-allanite indique une mise en place au Néoarchéen à 2 738 +25/-21 Ma, ce qui donne à penser que, dans la région du lac Flint, les roches plutoniques du Paléoprotérozoïque encaissées dans le socle archéen n'occuperaient pas une étendue aussi grande qu'on le supposait auparavant. Un monzogranite à mégacristaux de feldspath potassique précédemment mis en corrélation avec le batholite de Cumberland (de 1,87 à 1,85 Ga, en grande partie) a livré un âge de cristallisation de 1 897 +7/-4 Ma, nous indiquant ainsi que les enclaves de psammite dans le pluton doivent être plus anciennes que 1,90 Ga environ.

INTRODUCTION

The Precambrian geology of central Baffin Island comprises the Archean Rae Province and the northern margin of the Trans-Hudson Orogen (Fig. 1). The bedrock geology of this area was mapped at reconnaissance scale in the late 1960s (Jackson, 1969, 1978, 1984, 2000; Jackson and Taylor, 1972) and in the mid 1970s (Morgan et al., 1975, 1976; Jackson and Morgan, 1978; Morgan, 1983). This work was followed by more detailed field investigations in parts of NTS areas 27 B, 37 A, and 37 C (Tippett, 1985; Henderson et al., 1988, 1989; Henderson and Henderson, 1994; Bethune and Scammell, 1997). In 2000, the Geological Survey of Canada and the Canada–Nunavut Geoscience Office began a three-year multidisciplinary mapping program centred on the Paleoproterozoic Foxe Fold Belt in central Baffin Island (Fig. 1). The results for the first two seasons of fieldwork are summarized in Corrigan et al. (2001), St-Onge et al. (2001a, b, c, d, 2002a, b, c), and Scott et al. (2002). One of the primary goals of the Central Baffin Multidisciplinary Project is to provide precise U-Pb radiometric ages for key geological units, identified through the mapping program, that will be essential to the understanding of the tectonostratigraphic, magmatic, metamorphic, and metallogenic evolution of the northern margin of the Trans-Hudson Orogen.

This report addresses partially this aim and provides new geochronological constraints on field observations made during the current mapping program. Preliminary U-Pb zircon data are presented for four metaplutonic samples that provide an absolute framework for the timing of magmatic, deformation, and metamorphic events in central Baffin Island.

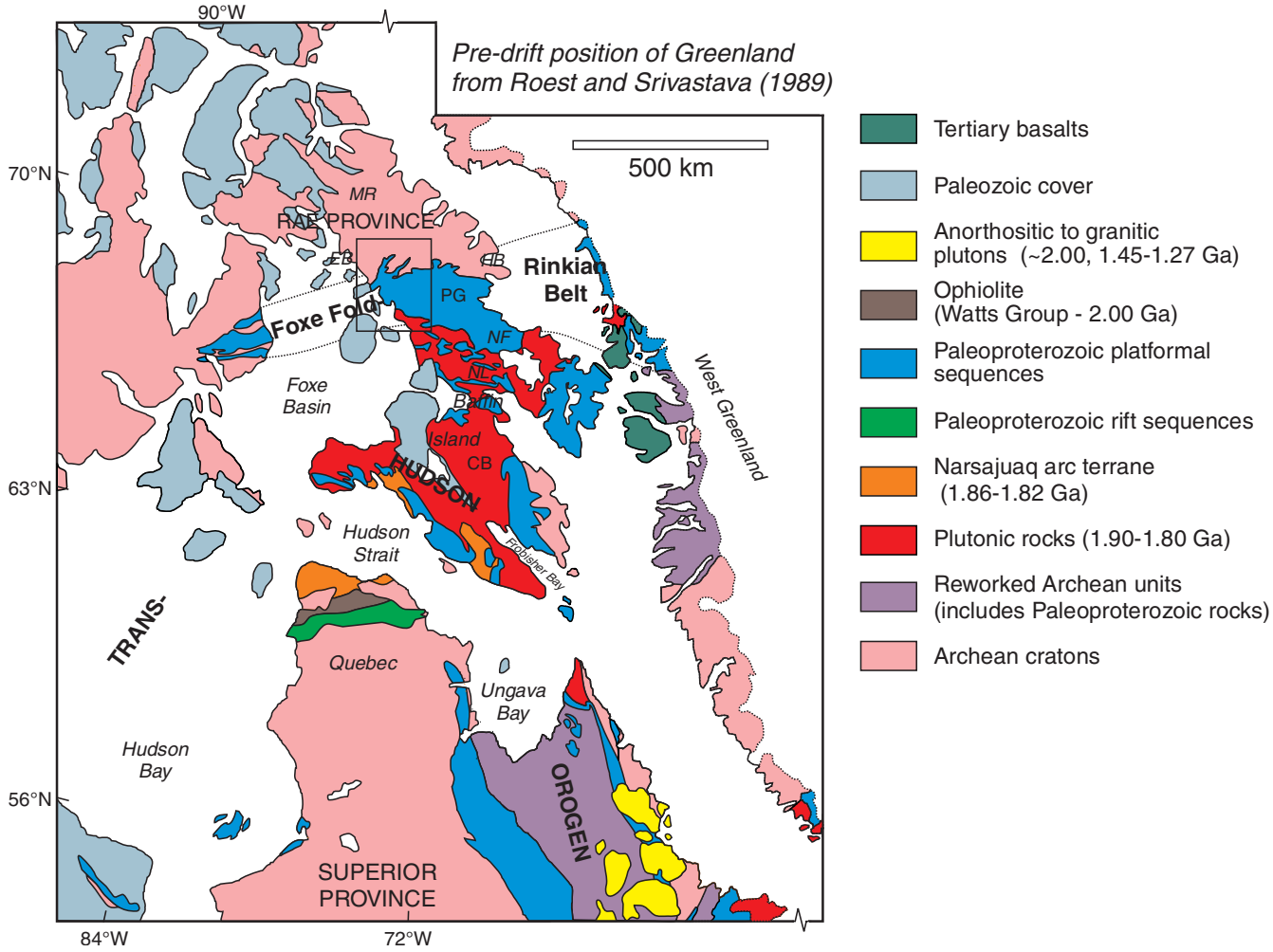

Figure 1. *Geological map of parts of northeastern Canada and West Greenland, showing the surface extent of the Trans-Hudson Orogen and the correlation between the Foxe Fold and Rinkian belts. Box outlines location of study area (Fig. 2).* Modified from *Hoffman (1989) with pre-drift restoration of Greenland from Roest and Srivastava (1989). CB, Cumberland batholith; EB, Eqe Bay; HB, Home Bay; MR, Mary River; NL, Nettilling Lake; NF, Nudlung Fiord; PG, Piling Group.*

GEOLOGICAL SETTING

The study area straddles the northern margin of the 1.9–1.8 Ga Trans-Hudson Orogen (Hoffman, 1988; Lewry and Collerson, 1990) on Baffin Island (Fig. 1). The orogenic margin (Foxe Fold Belt; Jackson and Taylor, 1972) is correlated to the east with the Rinkian Belt in West Greenland and extends along strike to the west onto Melville Peninsula (Taylor, 1982; Hoffman, 1988). On Baffin Island, the Foxe Fold Belt is flanked to the north by the Archean Rae Province and to the south by the 1.87–1.85 Cumberland batholith. In the following sections, the rocks are described sequentially from north to south.

Archean Rae Province

The Archean Rae Province, the structurally lowest level exposed in the project area, is composed predominantly of banded granodioritic to monzogranitic orthogneiss, migmatitic granitoid bodies, migmatitic pelitic to psammitic rocks and rare amphibolite, and younger felsic plutonic rocks (Fig. 2). Previous high-precision U-Pb geochronological work in the Rae Province in central Baffin Island is limited to ages for plutonic and supracrustal rocks in the Eqe Bay and Mary River areas, northwest of the study area (Table 1, Fig. 1). The oldest plutonic units within the Archean basement range between 2851 +20/–17 and 2775 ± 1 Ma (Jackson et al., 1990; Bethune and Scammell, 1997). Felsic volcanic rocks of the Mary River Group gave zircon ages between 2732 +8/–7

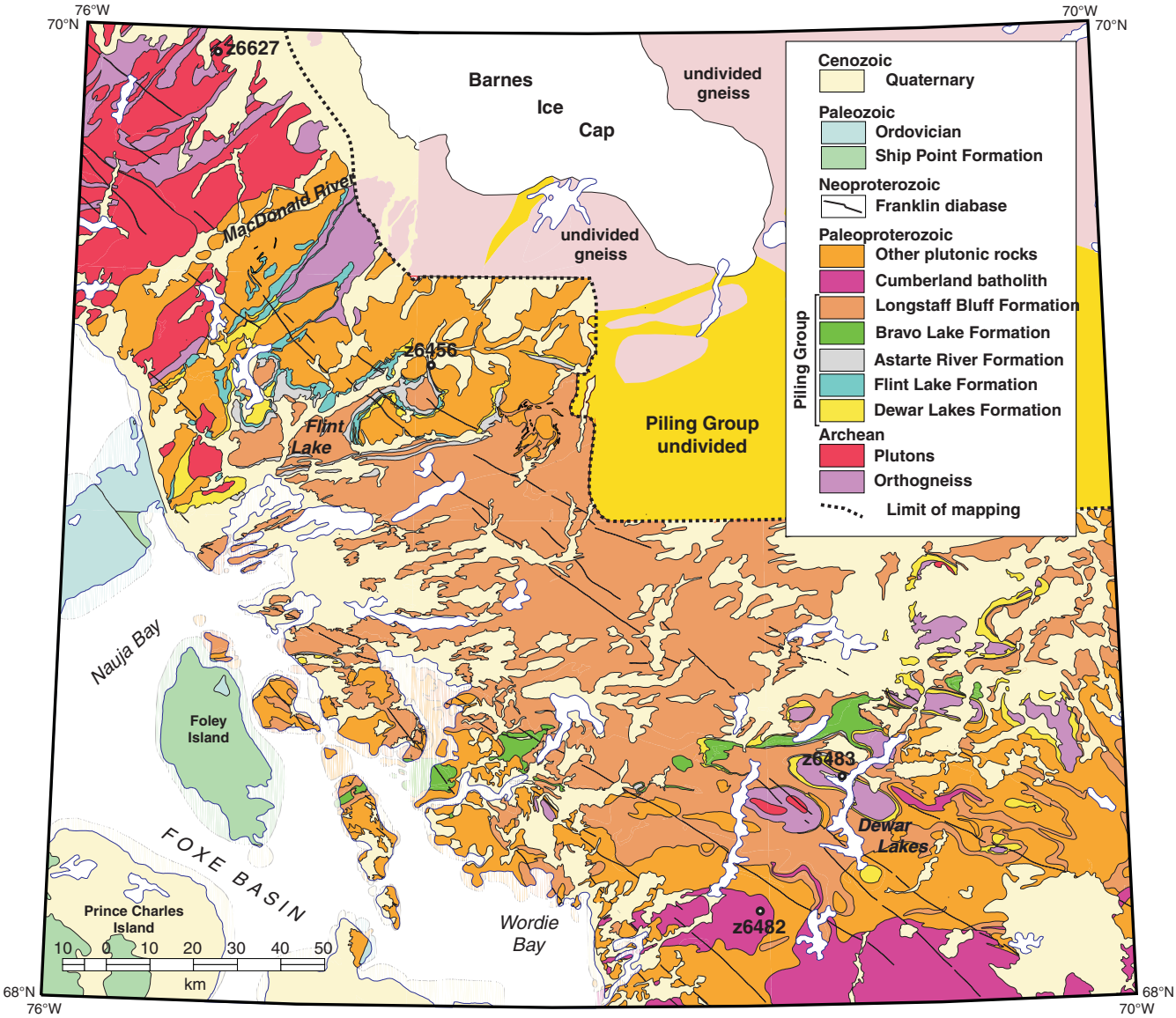

*Figure 2. Generalized geology of the study area, central Baffin Island (*after *St-Onge et al., 2001a, b, c, d, 2002a, b, c). Locations of analyzed samples are shown.*

Table 1. Summary of U-Pb dates from central and north-central Baffin Island.

Lab no.	Rock type	Age (Ma)	Interpretation
RAE PROVINCE Archean and Paleoproterozoic plutonic rocks			
Eqe Bay area			
z3344	Granitoid cobble in Mary River Gp conglomerate	≥2843 ± 2 (2845 ± 2 to 2892 ± 2)[Z,2]	Crystallization age (xenocrysts)
z404	Granitic gneiss	2778 ± 1[Z,2]	Crystallization age
z3654	Quartzofeldspathic gneiss	2775 ± 1 (2834 ± 1, 2844 ± 2)[Z,2]	Crystallization age (xenocrysts)
z3825	Quartz diorite	2726 +3/-2[Z,2]	Crystallization age
z3911	Monzodiorite	2725 ± 1[Z,2]	Crystallization age
z3346	Quartz monzodiorite	2717 ± 1 (2742 ± 3)[Z,2]	Crystallization age (xenocryst)
z403	Megacrystic granite	2726 ± 2[Z,2]	Crystallization age
z3621	Megacrystic granite	2721 ± 3[Z,2]	Crystallization age
z3655	Megacrystic granite	2714 ± 2[Z,2]	Crystallization age
z3910	Gabbro	2717 +16/-13[Z,2]	Crystallization age
z3622	Pegmatite	1826 ± 2[Z,2]	Crystallization age
z3343	Biotite granite	1823 +7/-4[Z,2]	Crystallization age
Mary River area			
z989	Trondhjemite-tonalite	2851 +20/-17[Z,3]	Crystallization age
z1013	Quartz monzodiorite	2709 +4/-3[Z,3]	Crystallization age
Study area			
z6483	Tonalite	2827 +8/-7[Z,4]	Crystallization age
z6456	Biotite-allanite monzogranite	2738 +25/-21[Z,4]	Crystallization age
z6627	Megacrystic monzogranite	2719 ± 4[Z,4]	Crystallization age
Mary River Group			
Eqe Bay greenstone belt, Eqe Bay area			
z335	Quartz-feldspar porphyritic rhyodacite	2732 +8/-7 (2759 ± 2, 2962 ± 5)[Z,2]	Crystallization age (xenocrysts)
Isotorq greenstone belt, Eqe Bay area			
z3823	Quartz-feldspar porphyry	2725 +4/-3[Z,2]	Crystallization age
Mary River area			
z993	Dacite	2718 +5/-3[Z,3]	Crystallization age
Paleoproterozoic metamorphism and deformation			
Eqe Bay area			
z3607	Amphibolite	1845 ± 5[T,2] 1824 ± 2[Z,2]	Prograde mineral growth Age of metamorphism
z3345	Pelitic gneiss	1826 ± 1[Z,2], 1821 ± 1[M,2]	Age of metamorphism
z404	Granitic gneiss	1824 ± 5[Z,2]	Age of metamorphism
z3654	Quartzofeldspathic gneiss	1818 ± 1[T,2]	Age of metamorphism
Home Bay area			
z516	Synkinematic tonalite pegmatite	1806 +15/-8[Z,1]	Age of late D_{3P} deformation
TRANS-HUDSON OROGEN Paleoproterozoic magmatism			
Study area			
z6482	K-feldspar-megacrystic monzogranite	1897 +7/-4[Z,4]	Crystallization age
Cumberland batholith, Nudlung Fiord and Nettilling Lake areas			
z1068	Charnockite	1853 +15/-11[Z,3] 1832.7 ± 1.2, 1831.4 ± 1.0[M,3]	Crystallization age Cooling ages
z1090	Orthopyroxene monzogranite	1854 ± 2[M,3]	Minimum crystallization age

[Z] U-Pb age determination on zircon
[M] U-Pb age determination on monazite
[T] U-Pb age determination on titanite
[1] age determination by Henderson and Loveridge (1981)
[2] age determination by Bethune and Scammell (1997)
[3] age determination by Jackson et al. (1990) and Jackson (2000)
[4] age determination by this study
For the Cumberland batholith, only the ages from central Baffin Island are indicated

and 2718 +5/–3 Ma (Jackson et al., 1990; Bethune and Scammell, 1997). Late monzodioritic to granitic plutons, intrusive into supracrustal rocks of the Mary River Group, range in age from 2726 +3/–2 to 2709 +4/–3 Ma. East of Eqe Bay, a north-trending dyke of medium-grained gabbro, intrusive into Archean gneiss and granite, gave an age of 2717 +16/–13 Ma (Bethune and Scammell, 1997).

Paleoproterozoic Piling Group

The Foxe Fold Belt, in the central portion of the study area, is dominated by metasedimentary rocks of the Paleoproterozoic Piling Group (Fig. 2; Morgan et al., 1975, 1976; Morgan, 1983; Henderson et al., 1988, 1989; Henderson and Henderson, 1994). The Piling Group comprises 1) a thin, lower, platformal sequence of quartzite, muscovite schist, and minor iron-formation (Dewar Lakes Formation); overlain in the north by 2) dolomitic and calcareous marble with calc-silicate rocks and minor chert (Flint Lake Formation); and in the south by 3) mafic to ultramafic volcanic to intrusive rocks with interstratified volcaniclastic and siliciclastic metasedimentary rocks (Bravo Lake Formation; Tippett, 1985; de Kemp et al., 2002; Scott et al., 2002); 4) an upper foredeep sequence of ferruginous psammite, black shale, and sulphide-facies iron-formation (Astarte River formation); and 5) a thick assemblage of psammite and feldspathic wacke with minor semipelite, pelite, and calc-silicate pods (Longstaff Bluff Formation) that blankets the entire area. In the vicinity of Dewar Lakes (Fig. 2), domal structural culminations cored by possible Archean migmatitic orthogneiss and layered gneiss (Jackson, 1969; Tippett, 1985; Henderson et al., 1988; Corrigan et al., 2001) are separated from the Longstaff Bluff Formation by a relatively thin apron of siliciclastic and chemical metasedimentary rocks interpreted as Dewar Lakes Formation (Henderson and Henderson, 1994; Corrigan et al., 2001).

Detrital zircons from a quartzite of the Dewar Lakes Formation have a bimodal age distribution (R. Parrish, unpublished data, reported in Henderson and Parrish, 1992), with an older Archean population (2.85–2.84 Ga) and a younger Paleoproterozoic population (2.18–2.16 Ga). The oldest detrital zircons are similar in age to dated plutonic rocks in the Rae craton to the northwest of the Piling Group (Table 1, Fig. 1). The younger population provides a maximum depositional age of ca. 2.16 Ga for the entire Piling Group. A U-Pb zircon age of 1883.3 ± 4.7 Ma for a diorite sill within the Bravo Lake Formation has been interpreted as an approximate age for this unit (op. cit.; see also Henderson and Henderson, 1994) and suggests that the overlying turbidites of the Longstaff Bluff Formation are younger than ca. 1883 Ma.

Southern Paleoproterozoic plutonic rocks

The southern part of the study area is dominated by compositionally diverse Paleoproterozoic plutonic rocks (Fig. 2; Corrigan et al., 2001; St-Onge et al., 2001d). The oldest intrusive bodies consist of grey, medium- to coarse-grained, predominantly K-feldspar–megacrystic, elongate plutons of granodioritic to monzogranitic composition. They commonly contain enclaves of foliated and folded migmatitic metasedimentary rocks interpreted as Longstaff Bluff Formation. On the basis of field relationships, these biotite±hornblende±garnet–bearing plutonic rocks were correlated with the 1.87–1.85 Ga Cumberland batholith (Corrigan et al., 2001; St-Onge et al., 2001d). The older plutons are intruded by whitish to light pink, medium-grained to pegmatitic, garnet-biotite±muscovite±cordierite monzogranite dykes and plutons. A southward increase in metamorphic grade, documented by pelitic mineral assemblages in the Longstaff Bluff Formation, suggests that the white monzogranite is derived from partial to total melting of Piling Group metasedimentary rocks (Corrigan et al., 2001; St-Onge et al., 2001d). Finally, small bodies of massive, pink, biotite syenogranite and monzogranite cut the white monzogranite.

Deformation and metamorphism

Deformation and metamorphism in the Archean basement and its Paleoproterozoic cover are polyphase (Corrigan et al., 2001; St-Onge et al., 2001a, b, c, d). The oldest deformation structures and mineral assemblages are found in Archean basement plutonic and supracrustal rocks. This event (D_{1A}) produced a strong transposition fabric and was accompanied by mid- to upper-amphibolite–facies metamorphism. The high-grade fabrics are crosscut by late Archean plutons. In the Eqe Bay area, Archean metamorphism and deformation preceded emplacement of a ca. 2726 Ma quartz diorite (Table 1), which crosscuts strongly foliated Mary River Group turbidites metamorphosed to mid-amphibolite facies (Bethune and Scammell, 1997).

In the overlying Piling Group, the presence of numerous low-angle repetitions and tight, intrafolial isoclinal folds of bedding in the lower sequence, and sharp, large-scale fold limb truncations in the upper sequence, attest to an early (D_{1P}) Proterozoic, thin-skinned deformation event. Deformation and mineral-growth relationships in Piling Group metasedimentary rocks suggest that this event was both accompanied and outlived by regional peak metamorphic conditions.

Thrust imbrication was succeeded by two regional-scale folding episodes (D_{2P} and D_{3P}). The D_{2P} event was largely coaxial with D_{1P} and produced predominantly east-trending, tight to isoclinal, upright to mostly north-vergent, reclined and recumbent folds with shallow, doubly plunging axes. Field relations suggest that this event was accompanied by the emplacement of biotite syenogranite and monzogranite, and garnet-muscovite-biotite±tourmaline pegmatite (Corrigan et al., 2001). The involvement of Archean basement in the D_{2P} folding episode has led to the deformation being described as 'thick-skinned' (op. cit.). Uranium-lead dating of syn-peak granitic plutons and pegmatite bodies in Piling Group supracrustal rocks and in reworked Archean basement gneiss in the Eqe Bay area (Bethune and Scammell, 1997; Table 1) suggests that D_{2P} deformation occurred at ca. 1.83–1.82 Ga.

The D_{3P} event produced orogen-perpendicular, large-wavelength, upright open folds and also involved the Archean basement and its Paleoproterozoic cover. Interference of F_{3P} folds with F_{2P} folds resulted in the current dome-and-basin map pattern in the project area and is responsible for

the (?)Archean gneiss-cored domes in the Dewar Lakes area (Fig. 2; *see also* Henderson et al., 1988, 1989). The F_{3P} folds do not appear to have been accompanied by new metamorphic mineral growth. Henderson and Loveridge (1981) reported a U-Pb zircon age of 1806 +15/–8 Ma for a tonalite pegmatite interpreted to have been emplaced during D_{3P} folding (F_4 of Henderson and Loveridge, 1981; Table 1).

ANALYTICAL METHODS

Heavy minerals were concentrated from representative samples by standard crushing, grinding, hydrodynamic, and heavy-liquid techniques. Purification of the heavy-mineral concentrates was carried out using a Frantz™ LB-1 isodynamic separator. Zircon crystals were selected for analysis based on morphology, colour, optical clarity, rarity of fractures and inclusions, and absence of apparent cores. All zircon fractions were air-abraded following the method of Krogh (1982). The U-Pb analytical procedures used in this study are summarized in Parrish et al. (1987). Treatment of analytical errors follows that outlined by Roddick (1987), with regression analysis modified after York (1969). Analytical results are presented in Table 2 and displayed in the concordia diagrams, with age errors reported at the 2σ level.

URANIUM-LEAD RESULTS AND DISCUSSION

Southern Archean basement inliers

The presence of possible Archean basement inliers coring domal structural culminations in the vicinity of Dewar Lakes (Fig. 2) has been known since the early reconnaissance work

Table 2. U-Pb analytical data for plutonic samples from the northern margin of the Trans-Hudson Orogen, central Baffin Island.

Fraction[a]	Wt.[b] (μg)	U[b] (ppm)	Pb[b,c] (ppm)	Pb[d] (pg)	$^{206}Pb/^{204}Pb$[e]	$^{208}Pb/^{206}Pb$[f]	$^{206}Pb/^{238}U$[f]	$^{207}Pb/^{235}U$[f]	$^{207}Pb/^{206}Pb$[f]	$^{207}Pb/^{206}Pb$[g] Age (Ma)	Disc.[h] (%)
SAB-00-DC136 (z6483): biotite monzogranite (UTM Zone 19, 394256E, 7596768N)											
A1 pk,eu,spr,dia (6)	3	260	151	10	2269	0.111	0.5139±0.12	14.096±0.15	0.19894±0.06	2817.5±1.8	6.3
B1 c,eu,spr,dia (8)	3	287	172	4	8209	0.119	0.5269±0.12	14.498±0.14	0.19957±0.05	2822.7±1.5	4.1
B2 c,eu,spr,dia (3)	1	266	166	9	1453	0.159	0.5329±0.11	14.758±0.14	0.20086±0.07	2833.2±2.2	3.5
D1 c,eu,pr,dia (7)	4	385	219	6	7310	0.12	0.5015±0.15	13.755±0.16	0.19891±0.16	2817.3±1.6	8.5
D2 c,eu,pr,dia (2)	1	379	228	8	1837	0.126	0.5270±0.13	14.600±0.16	0.20092±0.07	2833.7±2.2	4.7
E1 c,sb,eq,dia (7)	4	113	57	48	255	0.09	0.4604±0.18	11.568±0.39	0.18221±0.30	2673.1±9.8	10.4
SAB-00-DC139 (z6627): megacrystic monzogranite (UTM Zone 18, 491314E, 7758823N)											
B1 c,sb,spr,dia (1)	2	324	189	4	4808	0.141	0.5107±0.10	13.121±0.12	0.18633±0.05	2710.1±1.7	2.3
B2 c,sb,spr,dia (1)	2	229	138	4	3507	0.156	0.5207±0.11	13.415±0.13	0.18686±0.06	2714.7±1.9	0.6
B3 c,sb,spr,dia (1)	2	212	131	6	1922	0.184	0.5229±0.13	13.525±0.14	0.18760±0.08	2721.2±2.5	0.4
C1 c,eu,spr,m-0.5° (1)	2	222	125	3	4133	0.134	0.4956±0.15	12.562±0.15	0.18384±0.09	2687.8±2.9	4.2
G1 c,eu,pr,m0° (2)	3	476	274	5	943	0.169	0.4946±0.11	12.507±0.16	0.18342±0.09	2684.0±3.0	4.2
SAB-00-DS35A (z6456): biotite-allanite monzogranite (UTM Zone 18, 543223E, 7689448N)											
B1 c,eu,pr,m1° (2)	1	395	204	3	3863	0.112	0.4665±0.12	11.256±0.14	0.17501±0.06	2606.1±1.8	6.4
C1 c,eu,spr,m1° (2)	1	82	49	6	428	0.177	0.5106±0.39	13.392±0.42	0.19021±0.26	2744.0±8.7	3.8
D2 c,eu,n,m1° (2)	1	288	145	2	3347	0.104	0.4595±0.30	10.933±0.30	0.17256±0.08	2582.6±2.7	6.7
D3 c,eu,n,m1° (2)	1	382	191	6	1497	0.126	0.4479±0.12	10.460±0.14	0.16937±0.07	2551.5±2.4	7.8
E2 c,eu,tip,m1° (1)	1	476	271	2	6693	0.119	0.5069±0.31	12.873±0.31	0.18419±0.07	2691.0±2.2	2.2
SAB-00-MSO62 (z6482): K-feldspar-megacrystic monzogranite (UTM Zone 18, 623700E, 7567600N)											
A1 c,eu,pr,dia (2)	3	184	70	2	5338	0.191	0.3383±0.23	5.405±0.21	0.11589±0.13	1893.7±4.6	0.9
B1 c,eu,spr,dia (3)	3	282	107	3	6178	0.173	0.3416±0.11	5.490±0.13	0.11657±0.07	1904.3±2.4	0.6
C1 c,sb,spr,dia (5)	6	222	82	4	6145	0.163	0.3366±0.11	5.365±0.13	0.11562±0.05	1889.5±1.9	1.2
D1 c,eu,eq,dia (5)	8	215	79	6	5846	0.157	0.3348±0.11	5.336±0.13	0.11558±0.05	1888.9±1.9	1.7
E1 c,sb,eq,dia (5)	2	171	64	4	1865	0.176	0.3400±0.14	5.434±0.17	0.11594±0.08	1894.6±3.0	0.5

[a]Grain characteristics: c, colourless; pk, pinkish; pb, pale brown; eu, euhedral; sb, subhedral; eq, equant; pr, prismatic (>3:1); spr, short prismatic (<3:1); n, needle. Magnetic properties: dia, diamagnetic; m-0.5°, magnetic at indicated side slope of Frantz. Number in parentheses following zircon descriptions indicates number of grains analyzed
[b]Uncertainties in concentrations estimated to be ±10%
[c]Radiogenic Pb
[d]Total common Pb in analysis corrected for fractionation and spike
[e]Measured ratio corrected for spike and Pb fractionation of 0.09 ± 0.045%/AMU
[f]Ratios corrected for spike, fractionation, blank and initial common Pb (Stacey-Kramers model Pb composition equivalent to the $^{207}Pb/^{206}Pb$ age). Errors quoted are 1σ in %.
[g]Age error is ±2σ in Ma.
[h]Discordance (along discordia to origin).

Figure 3. Layered tonalite-monzogranite-diorite gneiss from a domal culmination northwest of Dewar Lakes (sample locality z6483). Hammer is 35 cm long.

of Jackson (1969). The basement inliers consist of migmatitic and layered gneiss of biotite±hornblende granodiorite to monzogranite composition and more weakly deformed plutonic rocks. Also present within the gneiss are layers ranging in composition from biotite±hornblende tonalite and hornblende±biotite diorite to rare clinopyroxenite. To test the proposed Archean age (Tippett, 1985; Henderson and Henderson, 1994; Corrigan et al., 2001; Scott et al., 2002), a representative sample of the monzogranite component of a layered gneiss was collected from a domal culmination on the northwest side of Dewar Lakes (Fig. 2, 3).

Biotite monzogranite (SAB-00-DC136, z6483)

The biotite monzogranite contained abundant pink to colourless, moderate-quality zircons of variable morphology, ranging from stubby to elongate prisms (length:width ratios of 2:1–5:1) with straight edges and rounded terminations to clear equant crystals. Five multigrain fractions (n = 2–8) of the dominant prismatic population of zircons (fractions A1, B1, B2, D1, and D2) are variably discordant (3.5–8.5%), with $^{207}Pb/^{206}Pb$ ages between 2817 and 2834 Ma (Table 2). A sixth fraction (E1) of more equant crystals yields a significantly younger $^{207}Pb/^{206}Pb$ age of 2673 Ma (10.4% discordant). Taken together with distinctly lower uranium concentrations (113 ppm vs. 260–385 ppm; Table 2), these characteristics suggest that the equant zircons are of metamorphic origin. The other five fractions form a poorly defined discordia (not shown in Fig. 4) with an upper intercept of 2838 +19/–13 Ma and a high mean square of weighted deviates (MSWD) of 36.08. Excluding fractions B2 and D2, which show signs of possible minor inheritance, produces a slightly younger upper intercept of 2827 +8/–7 Ma but a lower MSWD of 5.81 (lower intercept = 277 +233/–235 Ma; Fig. 4). The upper intercept age of 2827 +8/–7 Ma is interpreted as the crystallization age of the biotite monzogranite.

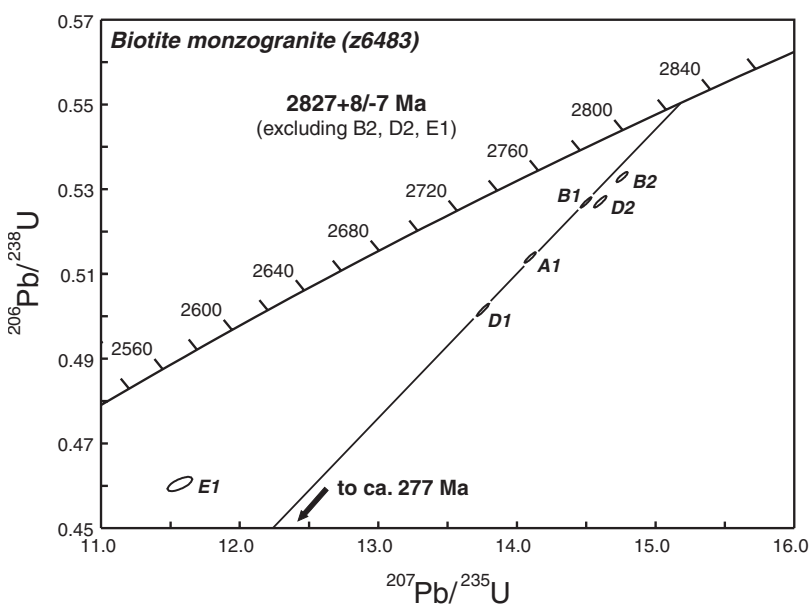

Figure 4.

U-Pb concordia diagram for a biotite monzogranite (sample z6483) from a domal culmination near Dewar Lakes. Error ellipses are 2σ.

The 2827 +8/–7 Ma age for this monzogranite represents the first confirmation that Archean crust cores the antiformal culminations in the Dewar Lakes area. It falls within error of the 2851 +20/–17 Ma age for a foliated tonalite (Jackson et al., 1990) that is basement to the Mary River Group in north-central Baffin Island, and is only slightly younger than the 2843 ± 2 Ma granitic cobble (Bethune and Scammell, 1997) from a Mary River Group conglomerate in the Eqe Bay area (Table 1, Fig. 1). The compositional and age similarities outlined above are consistent with the recent suggestion by St-Onge et al. (2002c) and Scott et al. (2002) that the domal structural culminations in the Dewar Lakes area represent erosional windows exposing the southernmost extent of the Archean Rae craton.

Northern Archean basement

Archean orthogneissic and supracrustal rocks northwest and southeast of the MacDonald River (Fig. 2) are pervasively intruded by massive to variably foliated, recrystallized plutonic rocks of predominantly biotite monzogranite to syenogranite composition, and by distinct bodies of biotite±hornblende, K-feldspar–megacrystic monzogranite and granodiorite. These late intrusions crosscut fabrics (D_{1A}) of mid- to upper-amphibolite grade preserved in the older orthogneiss units. A sample of megacrystic monzogranite (Fig. 2, 5) was collected to document the age of granitic plutonism in the Archean Rae craton north of the Piling Group, and to provide a lower age limit for the timing of the earliest Archean metamorphic and deformation event (D_{1A}).

Megacrystic monzogranite (SAB-00-DC139, z6627)

Zircon separated from the megacrystic monzogranite consists of colourless to pale brown, subhedral to euhedral, short to elongate prisms (2:1–5:1) containing varying amounts of fractures and rod-shaped inclusions. Analyses of four single-grain fractions (B1, B2, B3, and C1) and one multigrain fraction (G1; n = 2) yielded variably discordant results (0.4–4.2%; Table 2). A regression line through the three most collinear fractions (B2, C1, and G2) intersects concordia at 2719 ± 4 Ma and 1125 ± 98 Ma (MSWD = 1.19; Fig. 6). Fractions B1 and B3 plot below the discordia line, possibly owing to the presence of a minor component of inherited Pb. The upper intercept of 2719 ± 4 Ma is interpreted as the best estimate for the crystallization age of the megacrystic monzogranite.

The 2719 ± 4 Ma megacrystic monzogranite is temporally and lithologically similar to the ca. 2726–2714 Ma (Bethune and Scammell, 1997) K-feldspar–megacrystic granite bodies from the Eqe Bay area (Table 1), implying that these plutonic rocks belong to the same suite. The new result suggests that high-grade metamorphism and deformation (D_{1A}) of the host Archean gneiss must have occurred sometime prior to ca. 2.72 Ga.

Figure 5. *K-feldspar megacrystic monzogranite (sample locality z6627). Coin is 2.2 cm in diameter.*

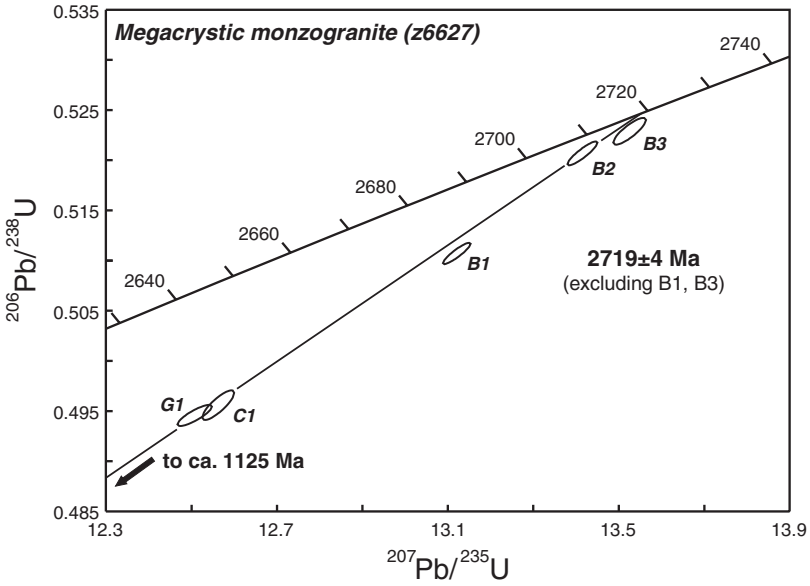

Figure 6.

U-Pb concordia diagram for a K-feldspar megacrystic monzogranite (sample z6627) from the Archean basement north of the Piling Group. Error ellipses are 2σ.

Archean–Paleoproterozoic plutonic rocks

In the vicinity of the contact between the Archean basement and Paleoproterozoic cover in the Flint Lake area (Fig. 2), the distribution of Archean basement is complicated by the presence of biotite-allanite±hornblende monzogranite, granodiorite, and syenogranite that appear to be intrusive into metasedimentary units of the Paleoproterozoic Piling Group. Unlike the often foliated, completely recrystallized, and/or layered Archean basement plutonic rocks that generally sit structurally beneath the Piling Group, these younger plutons tend to be massive, contain rafts and xenoliths of marble, psammite, quartzofeldspathic orthogneiss, and quartz diorite, and commonly sit structurally above the Piling Group. These observations led Corrigan et al. (2001) and St-Onge et al. (2001b) to suggest that the Archean basement in the Flint Lake area, as well as in the area of the MacDonald River, is encumbered by a number of syn- to post-tectonic felsic plutons of likely Proterozoic age (*see* Fig. 2). A sample of biotite-allanite monzogranite (Fig. 7) was collected on top of a cliff along the southeast side of Flint Lake (Fig. 2) to determine whether this area is underlain by Archean basement or Proterozoic plutonic rocks. Along the cliff face, a monzogranite is clearly intrusive into underlying, pink, quartz-rich metasedimentary rocks on strike with supracrustal rocks of the Paleoproterozoic Dewar Lakes Formation.

Figure 7. *Coarse-grained biotite-allanite monzogranite (sample locality z6456). Pen is 14 cm long.*

Biotite-allanite monzogranite (SAB-00-DS35A, z6456)

Zircon recovered from the biotite-allanite monzogranite is of mediocre quality, consisting of cloudy to clear and colourless, prismatic (2:1–3:1) to subequant crystals. Concentric zoning and core-overgrowth relationships were observed by transmitted-light microscopy. Four multigrain fractions (B1, C1, D2, and D3; n = 2) and one single-grain fraction (E2) were analyzed (Table 2). The least discordant (2.2%) fraction (E2), corresponding to a clear tip physically separated from its core, gave a $^{207}Pb/^{206}Pb$ age of 2691 ± 2 Ma (Fig. 8). A discordia line through four of the five fractions, including fraction E2, gives an upper intercept of 2738 +25/–21 Ma and a lower intercept of 1656 ± 91 Ma (MSWD = 2.93). Fraction C1, with a $^{207}Pb/^{206}Pb$ age of 2744 ± 9 Ma, is interpreted to contain a minor component of inherited Pb. The best estimate for the age of the biotite-allanite monzogranite is taken to be the upper intercept age of 2738 +25/–21 Ma.

Though imprecise, the 2738 +25/–21 Ma age for the biotite-allanite monzogranite is broadly similar to the known crystallization ages of Neoarchean granitoid rocks in the Archean Rae Province in the immediate vicinity (2726 +3/–2 to 2714 ± 2 Ma *from* Bethune and Scammell [1997], this study; Table 1). The Neoarchean age for the monzogranite dated in this study suggests that, although Paleoproterozoic plutonic rocks likely occur within the Archean basement in the Flint Lake area, these rocks may not be as extensive as

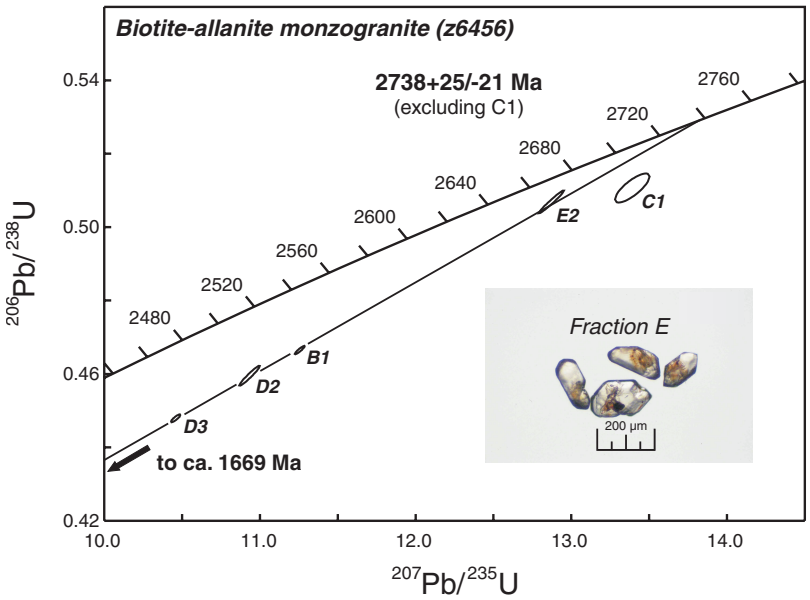

Figure 8.

U-Pb concordia diagram for a biotite-allanite monzogranite (sample z6456) from the Flint Lake area. Error ellipses are 2σ. Inset is a photomicrograph of unbroken clear tips (before abrasion) from fraction E.

previously suspected (*see* Fig. 2). In addition, the foregoing results indicate that either 1) the sampled biotite-allanite monzogranite is not the same granite that intrudes the pink, quartz-rich metasedimentary rocks along the cliff face; or 2) the latter metasedimentary rocks cannot be correlative with the <2.16 Ga Dewar Lakes Formation, and may instead represent a sliver of the ca. 2.73 Ga Mary River Group, which is known to be intruded by Neoarchean plutonic rocks. Evaluation of these hypotheses will require additional field work.

Paleoproterozoic magmatism

Immediately east of Wordie Bay (Fig. 2), an ovoid body of dark- to buff-weathering biotite±hornblende±garnet, K-feldspar–megacrystic monzogranite to granodiorite is intruded by white garnet-biotite±muscovite±cordierite monzogranite. The ovoid pluton commonly shows rapakivi textures and is weakly to strongly foliated. In order to test whether this body forms an integral part of the mostly 1.87–1.85 Ga Cumberland batholith (e.g. Corrigan et al., 2001; St-Onge et al., 2001d), a sample of rapakivi-textured, biotite-garnet±hornblende, K-feldspar–megacrystic monzogranite (Fig. 2, 9) was selected for U-Pb geochronology. At the sampling site, the monzogranite contains metre-scale enclaves of strongly deformed and metamorphosed psammite interpreted as Longstaff Bluff Formation (Fig. 10). The high-grade fabric (D_{1P}) in the psammite is not as well developed in the pluton; therefore, the crystallization age will provide a minimum age for at least part of the fabric that has affected the host metasedimentary rocks.

K-feldspar-megacrystic monzogranite (SAB-00-MSO62, z6482)

Zircon from the K-feldspar–megacrystic monzogranite forms clear to slightly cloudy, colourless, prismatic (2:1–4:1) to equant crystals with no visible cores but abundant, clear, rod- and bubble-shaped inclusions and cracks. Five

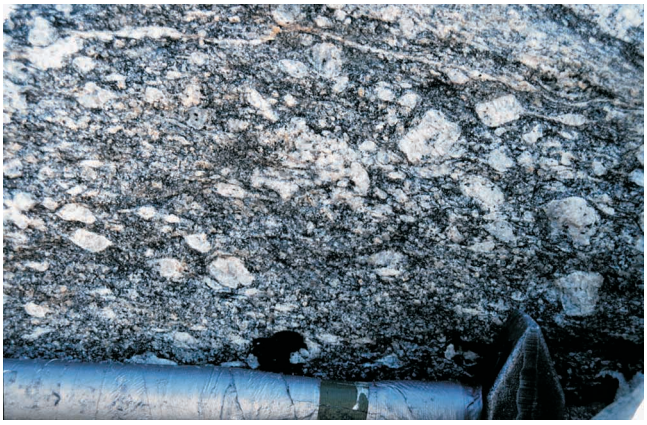

Figure 9. *Biotite-garnet±hornblende, K-feldspar–megacrystic monzogranite (sample locality z6482). Hammer is 35 cm long.*

Figure 10. *K-feldspar-megacrystic monzogranite (z6482; dark grey) with enclave of psammite, interpreted as Longstaff Bluff Formation, and crosscut by white garnet-bearing monzogranite. Hammer is 35 cm long.*

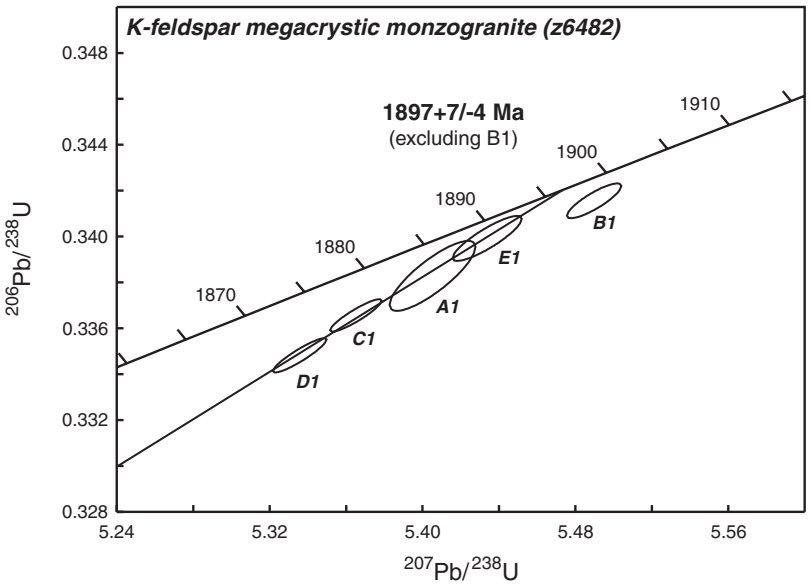

Figure 11.

U-Pb concordia diagram for a rapakivi-textured, K-feldspar-megacrystic monzogranite (sample z6482) east of Wordie Bay. Error ellipses are 2σ.

small-population (n = 2–5) fractions of prismatic to equant zircons were analyzed and give slightly discordant results (0.5–1.7%; Table 2). One zircon in fraction B1 had a cloudy interior, suggesting a component of inheritance. Data for the remaining four fractions (A1, C1, D1, and E1) are collinear, and regression yields an upper intercept of 1897 +7/–4 Ma and a lower intercept of 644 +334/–327 Ma (MSWD = 0.74; Fig. 11). The upper intercept age of 1897 +7/–4 Ma is interpreted as the magmatic crystallization age for the K-feldspar–megacrystic monzogranite.

The 1897 +7/–4 Ma age of the K-feldspar–megacrystic monzogranite, coupled with field relationships, clearly indicates that 1) the psammite, present as enclaves within the pluton and interpreted as Longstaff Bluff Formation, must be older than ca. 1.90 Ga; and 2) significant high-grade deformation (D_{1P}) of the psammite occurred prior to this time. A minimum age of 1897 +7/–4 Ma for deposition of the Longstaff Bluff Formation appears at odds with the age of 1883.3 ± 4.7 Ma (Henderson and Parrish, 1992) obtained for a (?)pene-contemporaneous diorite sill from the underlying Bravo Lake Formation. As indicated by Scott et al. (2002), however, it is also possible that the dated sill forms part of a distinctly younger magmatic event, in which case the minimum age bracket of 1.90 Ga for the Longstaff Bluff Formation would hold. Alternatively, the psammite enclaves in the K-feldspar–megacrystic monzogranite could be unrelated to the Longstaff Bluff Formation.

The crystallization age of 1897 +7/–4 Ma for the rapakivi-textured, biotite-garnet±hornblende, K-feldspar–megacrystic monzogranite is not characteristic of ages derived from chiefly biotite±orthopyroxene±garnet–bearing monzogranite bodies of the Cumberland batholith, which predominantly range between 1869 +9/–3 and 1848 ± 2 Ma (Jackson et al., 1990; Wodicka and Scott, 1997; Scott and Wodicka, 1998; Scott, 1999). Therefore, although the previous suggestion that the K-feldspar–megacrystic monzogranite pluton forms an integral part of the Cumberland batholith cannot be entirely excluded, the apparent age differences cast doubt on this inference. The above hypotheses will be tested by further field work and ongoing geochronological and tracer isotopic studies on both the K-feldspar–megacrystic plutonic rocks and the various supracrustal sequences of the Piling Group, including the Longstaff Bluff and Bravo Lake formations.

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REFERENCES

Bethune, K.M. and Scammell, R.J.
1997: Legend and descriptive notes, Koch Island area, District of Franklin, Northwest Territories (part of NTS 37 C); Geological Survey of Canada, Open File 3391.

Corrigan, D., Scott, D.J., and St-Onge, M.R.
2001: Geology of the northern margin of the Trans-Hudson Orogen (Foxe Fold Belt), central Baffin Island, Nunavut; Geological Survey of Canada, Current Research 2001-C23, 11 p.

de Kemp, E.A., Sherwin, T., Ryder, I., Davies, A., and Snyder, D.
2002: Detailed stratigraphic, structural and 3-D mapping of the basal surface of the Paleoproterozoic Bravo Lake Formation, Nadluardjuk Lake area, central Baffin Island, Nunavut; Geological Survey of Canada, Current Research 2002-C18, 10 p.

Henderson, J.R. and Henderson, M.N.
1994: Geology of the Dewar Lakes area, central Baffin Island, District of Franklin, N.W.T. (parts of NTS 27 B and 37 A); Geological Survey of Canada, Open File 2924, scale 1:100 000.

Henderson, J.R. and Loveridge, W.D.
1981: Age and geological significance of a tonalite pegmatite from east-central Baffin Island; *in* Current Research, Part C (*including* Rb-Sr and U-Pb Isotopic Age Studies: Report 4); Geological Survey of Canada, Paper 81-1C, p. 135–137.

Henderson, J.R. and Parrish, R.R.
1992: Geochronology and structural geology of the Early Proterozoic Foxe–Rinkian orogen, Baffin Island, N.W.T.; Geological Survey of Canada, Current Activities Forum, p. 12.

Henderson, J.R., Grocott, J., Henderson, M.N., Falardeau, F., and Heijke, P.
1988: Results of field work near Dewar Lakes, Baffin Island, N.W.T.; *in* Current Research, Part C; Geological Survey of Canada, Paper 88-1C, p. 101–108.

Henderson, J.R., Grocott, J., Henderson, M.N., and Perreault, S.
1989: Tectonic history of the Lower Proterozoic Foxe–Rinkian Belt in central Baffin Island, N.W.T.; *in* Current Research, Part C; Geological Survey of Canada, Paper 89-1C, p. 186–187.

Hoffman, P.H.
1988: United Plates of America, the birth of a craton: Early Proterozoic assembly and growth of Laurentia; Annual Reviews of Earth and Planetary Sciences, v. 16, p. 543–603.
1989: Precambrian geology and tectonic history of North America; *in* The Geology of North America – An Overview, (ed.) A.W. Bally and A.R. Palmer; Geological Society of America, The Geology of North America, v. A, p. 447–512.

Jackson, G.D.
1969: Reconnaissance of north-central Baffin Island; *in* Report of Activities, Part A; Geological Survey of Canada, Paper 69-1, pt. A, p. 171–176.
1978: McBeth Gneiss Dome and associated Piling Group, central Baffin Island, District of Franklin; *in* Rubidium-Strontium Isotopic Age Studies, Report 2, (ed.) R.K. Wanless and W.D. Loveridge; Geological Survey of Canada, Paper 77-14, p. 1417.
1984: Geology, Clyde River, District of Franklin, Northwest Territories; Geological Survey of Canada, Map 1582A, scale 1:250 000 (with expanded legend and brief marginal notes).
2000: Geology of the Clyde–Cockburn Land map area, north-central Baffin Island, Nunavut; Geological Survey of Canada, Memoir 440, 303 p.

Jackson, G.D. and Taylor, F.C.
1972: Correlation of major Aphebian rock units in the northeastern Canadian Shield; Canadian Journal of Earth Sciences, v. 9, p. 1650–1669.

Jackson, G.D. and Morgan, W.C.
1978: Precambrian metamorphism on Baffin and Bylot islands; *in* Metamorphism in the Canadian Shield, (ed.) J.A. Fraser and W.W. Heywood; Geological Survey of Canada, Paper 78-10, p. 249–267.

Jackson, G.D., Hunt, P.A., Loveridge, W.D., and Parrish, R.R.
1990: Reconnaissance geochronology of Baffin Island, N.W.T.; *in* Radiogenic Age and Isotopic Studies: Report 3; Geological Survey of Canada, Paper 89-2, p. 123–148.

Krogh, T.E.
1982: Improved accuracy of U-Pb zircon ages by the creation of more concordant systems using an air abrasion technique; Geochimica et Cosmochimica Acta, v. 46, p. 637–649.

Lewry, J.F. and Collerson, K.D.
1990: The Trans-Hudson Orogen: extent, subdivisions, and problems; *in* The Early Proterozoic Trans-Hudson Orogen of North America, (ed.) J.F. Lewry and M.R. Stauffer; Geological Association of Canada, Special Paper 37, p. 1–14.

Morgan, W.C.
1983: Lake Gillian, District of Franklin, Northwest Territories; Geological Survey of Canada, Map 1560A, scale 1:250 000.

Morgan, W.C., Bourne, J., Herd, R.K., Pickett, J.W., and Tippett, C.R.
1975: Geology of the Foxe Fold Belt, Baffin Island, District of Franklin; *in* Report of Activities, Part A; Geological Survey of Canada, Paper 75-1A, p. 343–347.

Morgan, W.C., Okulitch, A.V., and Thompson, P.H.
1976: Stratigraphy, structure and metamorphism of the west half of the Foxe Fold Belt, Baffin Island; *in* Report of Activities, Part A; Geological Survey of Canada, Paper 76-1A, p. 387–391.

Parrish, R.R., Roddick, J.C., Loveridge, W.D., and Sullivan, R.W.
1987: Uranium-lead analytical techniques at the Geochronology Laboratory, Geological Survey of Canada; *in* Radiogenic Age and Isotopic Studies: Report 1; Geological Survey of Canada, Paper 87-2, p. 3–7.

Roddick, J.C.
1987: Generalized numerical error analysis with applications to geochronology and thermodynamics; Geochimica et Cosmochimica Acta, v. 51, p. 2129–2135.

Roest, W.R. and Srivastava, S.P.
1989: Sea-floor spreading in the Labrador Sea: a new reconstruction; Geology, v. 17, p. 1000–1003.

Scott, D.J.
1999: U-Pb geochronology of the eastern Hall Peninsula, southern Baffin Island, Canada: a northern link between the Archean of West Greenland and the Paleoproterozoic Torngat Orogen of northern Labrador; Precambrian Research, v. 93, p. 5–26.

Scott, D.J. and Wodicka, N.
1998: A second report on the U-Pb geochronology of southern Baffin Island, Northwest Territories; *in* Radiogenic Age and Isotopic Studies: Report 11; Geological Survey of Canada, Current Research 1998-F, p. 47–57.

Scott, D.J., St-Onge, M.R., and Corrigan, D.
2002: Geology of the Paleoproterozoic Piling Group and underlying Archean gneiss, central Baffin Island, Nunavut; Geological Survey of Canada, Current Research 2002-C17, 10 p.

St-Onge, M.R., Scott, D.J., and Corrigan, D.
2001a: Geology, MacDonald River, Nunavut; Geological Survey of Canada, Open File 3958, scale 1:100 000.
2001b: Geology, Flint Lake, Nunavut; Geological Survey of Canada, Open File 3959, scale 1:100 000.
2001c: Geology, Nadluardjuk Lake, Nunavut; Geological Survey of Canada, Open File 3960, scale 1:100 000.
2001d: Geology, Wordie Bay, Nunavut; Geological Survey of Canada, Open File 3961, scale 1:100 000.
2002a: Geology, north Tweedsmuir Island, Nunavut; Geological Survey of Canada, Open File 4199, scale 1:100 000.
2002b: Geology, Straits Bay, Nunavut; Geological Survey of Canada, Open File 4200, scale 1:100 000.
2002c: Geology, Dewar Lakes, Nunavut; Geological Survey of Canada, Open File 4201, scale 1:100 000.

Taylor, F.C.
1982: Precambrian geology of the Canadian North Borderlands; *in* Geology of the North Atlantic Borderlands, (ed.) J.W. Kerr, A.J. Fergusson, and L.C. Machan; Canadian Society of Petroleum Geologists, Memoir 7, p. 11–30.

Tippett, C.R.
1985: Geology of a transect through the southern margin of the Foxe Fold Belt, Central Baffin Island, District of Franklin; Geological Survey of Canada, Open File 1110, 77 p.

Wodicka, N. and Scott, D.J.
1997: A preliminary report on the U-Pb geochronology of the Meta Incognita Peninsula, southern Baffin Island, Northwest Territories; *in* Current Research 1997-C; Geological Survey of Canada, p. 167–178.

York, D.
1969: Least squares fitting of a line with correlated errors; Earth and Planetary Science Letters, v. 5, p. 320–324.

Geological Survey of Canada Project 000007