# CHAPTER 6

# PALEOPROTEROZOIC MAKKOVIK PROVINCE ($P_{2C}$, $P_{3A}$ 1900–1700 Ma)

## 6.1 SYN-MAKKOVIKIAN AILLIK GROUP (1885–1850 Ma)

Aillik Group and correlative supracrustal units represent the oldest recognized rocks present in the Cape Harrison domain. Although they do not constitute a major lithological entity in the region embraced by this report, the rocks have been of enduring interest (including economic), hence it is felt worthwhile to review briefly their history of investigation and concomitant evolution of nomenclature.

Rocks now included as part of the Aillik Group were first recognized as supracrustal (conglomerate, quartzite, metasandstone), but not named, by Daly (1902) in the Pamiulik Point and Aillik Bay areas. The rocks were redescribed by Kranck (1939) and named Aillik formation. Kranck (1953) modified his name to Aillik Series, a name adopted by Douglas (1953), who mentions that dolomitic and argillaceous rocks are also present. The term 'Aillik Group' was introduced as a correction by King (1963) in his M.Sc. thesis to meet formal conventions of stratigraphic nomenclature. King also recognized the presence of volcanic rocks. Perhaps unaware of King's correction, the term Aillik Series continued to be used (*e.g.*, Gandhi *et al.*, 1969; Clark, 1971), and renaming to Aillik Group was repeated by Stevenson (1970). By this time, the widespread existence of volcanic rocks was recognized, leading Marten (1977) to separate the mafic-volcanic-dominated rocks flanking Kaipokok Bay as the lower Aillik Group, from the felsic-volcanic-dominated rocks farther east, which then became the upper Aillik Group, although the nature of the contact between them remained uncertain (conformable *vs.* unconformable, and/or transposed). This two-fold division was used by Gower *et al.* (1982a) and the terms lower/Lower Aillik Group and upper/Upper Aillik Group remained in vogue for some time (*e.g.*, Schärer *et al.*, 1988; Kerr *et al.*, 1996), albeit with growing emphasis on their separate identities. That the two parts of the Aillik Group have little in common was determined through U–Pb dating. Schärer *et al.* (1988) provided U–Pb zircon ages for the Upper Aillik Group of 1861 +9/–3 Ma, 1856 ± 2 Ma and 1807 ± 3 Ma (but *see* below for further comment regarding the 1807 Ma date), and Ketchum *et al.* (2001b) obtained an age of 2178 ± 4 Ma from an intermediate tuff within Lower Aillik Group mafic volcanic rocks. This established that mafic and felsic volcanism was separated by *ca.* 300 million years (although detrital zircon from psammitic and semipelitic rocks overlying the mafic volcanic rocks demonstrated sedimentation postdating 2013 Ma). Ketchum *et al.* (2002) took the final nomenclature leap by renaming the Lower Aillik Group as the Post Hill Group and redefining the Upper Aillik Group as simply the Aillik Group. Strictly, redefining the Aillik Group in this way does not meet stratigraphic naming practices (a new name should have been introduced), but Ketchum *et al.*'s justification, that it is in keeping with the original Aillik Series/Group, has merit, and, in any case, the name has received general endorsement through subsequent usage.

The age of the Aillik Group is now well established through dating by Schärer *et al.* (1988), Ketchum *et al.* (2002), Hinchey and Raynor (2008), LaFlamme *et al.* (2013) and Sparkes and Davis (2013). Ages range from 1883 ± 7 Ma (Hinchey and Raynor, 2008) to 1852 ± 7 Ma (LaFlamme *et al.*, 2013). The much younger 1807 ± 3 Ma date of Schärer *et al.* (1988) mentioned in the previous paragraph is re-interpreted as related to the widespread 1800 Ma event rather than Aillik Group volcanism (Sinclair *et al.*, 2002). All dates, except two, are from the Aillik domain. The two from the Cape Harrison domain were obtained by Ketchum *et al.* (2002) and Sparkes and Davis (2013). Ketchum *et al.* (2002; sample 96MKJ-58c) reported a concordant U–Pb zircon age of 1853 ± 2 Ma from a quartz porphyry that intrudes foliated rhyolite on Double Island, and Sparkes and Davis (2013; sample GS-08-288) obtained a concordant U–Pb zircon age of 1855.2 ± 1.4 Ma from a crystal–lithic tuff from the South of Burnt Island felsic volcanic belt.

LaFlamme *et al.* (2013) commented that a systematic pattern of ages across their map area was not apparent in their data, but, by adding in the two easternmost dates, a generalized younging from west to east is suggested (Figure 6.1). It must be kept in mind, however, that the easternmost date is from intrusive porphyry, although it is a reasonable assumption that it is closely related to the extrusive magmatism. Two dates from Michelin Ridge (1856 ± 2 Ma and 1858 ± 2 Ma; Schärer *et al.*, 1988; Sparkes and Dunning, 2015) have been excluded from the plot because the sample sites are south of the Adlavik Brook fault, along which 20-km right-lateral displacement is postulated.

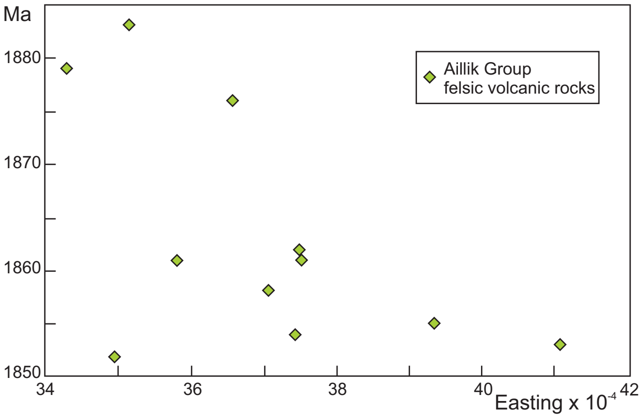


**Figure 6.1.** *Age of Aillik Group felsic volcanic rocks* vs. *Easting (suggesting eastward younging?).*

The Aillik Group in the Aillik domain has been investigated many times. More recent publications (which include references to earlier studies) can be subdivided into regional (Sinclair *et al.*, 2002; Hinchey, 2007; Hinchey and LaFlamme, 2009), geochronological (Ketchum *et al.*, 2002; Hinchey and Rayner, 2008; LaFlamme *et al.*, 2009), and mineralization/geochronological (Sparkes and Dunning, 2009, 2015; Sparkes and Davis, 2013). In the region covered by this report, rocks spatially contiguous with the Aillik Group in the Aillik domain form less than 5% of 'Aillik Group' data stations included here, and are not considered further as they have been thoroughly addressed elsewhere.

The remainder of this section concerns small isolated occurrences in the Cape Harrison domain (Figure 6.2) in the following areas: i) south of Burnt Island. ii) 'Little Double Island', iii) Double Island, iv) east of Tukialik Bay, v) west of Deus Cape, vi) Cape Harrison area, vii) Tessialuk Pond, viii) west of Byron Bay, and xi) other minor instances. They are described in turn below (more-or-less from west to east).

Stained-slab images of volcanic rocks from various areas within the Cape Harrison domain are given in Appendix 2, Slab images 6.1.

### 6.1.1 SOUTH OF BURNT ISLAND FELSIC VOLCANIC ROCKS ($P_{2C}$vf, $P_{2C}$vi)

The felsic volcanic and related supracrustal rocks south of Burnt Island underlie a north-northeast-trending area averaging about 5 km wide and extending 10 km southward from the coast to the Benedict fault. Efforts by the author to locate an equivalent belt south of the fault were unsuccessful. The belt is flanked to the west by the late-Makkovikian Stag Bay megacrystic granitoid rocks and to the east by the Labradorian Mount Benedict Intrusive Suite.

The supracrustal rocks are not shown on the maps of Kranck (1953), Christie *et al.* (1953), or Stevenson (1970). The first two references to them are by Burns (1979), who wrote that they were located in 1978 (during a Placer–Brinex joint mineral exploration program in the region), and by Archibald and Farrar (1979), who, also in 1978, collected muscovite for Ar–Ar dating from "a pegmatitic segregation in a roof pendant of Aillik Group metavolcanic rocks in the Benedict Mountains". Placer returned to the area in 1979 to carry out detailed mapping of the region at 1:20 000-scale, the results of which were reported by Davidson and Kowalczyk (1979).

The author, prior to his mapping of the same area, also in 1979, was aware that Placer was conducting mineral exploration in the region and that felsic volcanic rocks had been discovered south of Burnt Island, but had no detailed knowledge of the exploration activities. His initial geological sketch map (Gower, 1980) and subsequent 1:100 000-scale geological map (Gower, 1981), are based on his own data, but the revised 1:100 000-scale map for the region Gower (2010a; Benedict Mountains map region) incorpo-

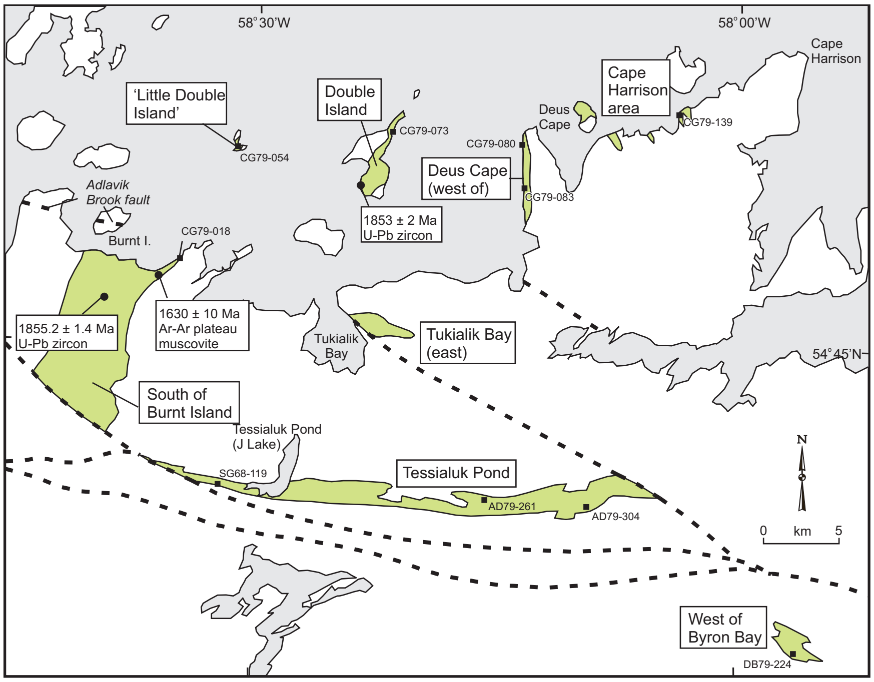


**Figure 6.2.** *Distribution of Aillik Group correlative rocks in the Cape Harrison domain.*

rates the more detailed mapping of Davidson and Kowalczyk (1979).

Some isotopic data are available. The reader is reminded of the earlier mention of a U–Pb zircon age of 1855.2 ± 1.4 Ma by Sparkes and Davis (2013) from a crystal-lithic tuff collected from the centre of the belt. In addition, the muscovite sample collected for $^{40}Ar$–$^{39}Ar$ dating by Archibald and Farrar (1979; sample A-78-5, from the northeast corner of the felsic volcanic belt) yielded a plateau age of 1630 ± 10 Ma. One Sm–Nd analysis was reported by Kerr and Fryer (1994). It has $T_{DM}$ = 1846 Ma and εNd = +3.89 (calculated here for 1855 Ma, rather than 1810 Ma, as done by Kerr and Fryer (*op. cit.*)). Note that Kerr and Fryer (1994) wondered, based on its lithogeochemical character, whether this sample of massive, undeformed porphyry might represent 1720 Ma volcanism, as its εNd signature is distinct from other 1860–1800 Ma rocks analyzed. The possibility remains that that the porphyry is intrusive and younger than its host rocks, but, at least, the supposition that the whole of the 'South of Burnt Island' felsic volcanic belt has a 1720 Ma age can be rejected.

Gower (1981) subdivided the supracrustal rocks into four parallel zones which, from east to west (and simplified), are: i) felsic agglomerates, ii) rhyolitic crystal–lithic tuffs, iii) quartz and/or feldspar porphyry, and iv) clastic sediments. In the context of Davidson and Kowalczyk's (1979) more detailed investigations this subdivision was abandoned by Gower (2010a). The rock types present are as follows.

*Felsic ash-flow pyroclastic rocks.* These are the dominant rock type. They weather pale pink, grey, green, or, locally, brick red, and have rhyodacitic to rhyolitic compositions. Texturally, they range from being featureless, aphanitic to fine grained and massive, to having a streaky appearance due to flow-banding, being fragmental, and/or having experienced deformation. Davidson and Kowalczyk (1979) describe them as ignimbritic flows and lapilli tuffs that have been intensely welded to create dense, resistant rocks, and that individual flows may be over 200 m thick, although less than 50 m is typical.

*Massive rhyolite and porphyritic rhyolite.* These are especially abundant in the eastern part of the belt and probably represent both extrusive and hypabyssal intrusive rocks. The porphyries carry euhedral to subhedral quartz and alkali-feldspar phenocrysts up to 1 cm diameter in a microcrystalline matrix, and may show flow banding. Sparkes and Davis (2013) reported spherolitic rhyolite.

*Ash-fall pyroclastic rocks.* These are well-bedded felsic tuffs having individual beds on millimetre to centimetre scale and displaying considerable colour variation between various light and dark layers.

*Intermediate (to mafic?) flows.* Rocks in this category are massive, grey-green, fine grained and sporadically porphyritic, and are mostly found on the east side of the belt.

*Clastic rocks.* These constitute a minor rock type that occurs as fine- to medium-grained, finely bedded arenaceous rocks, locally showing crossbedding (*e.g.*, CG79-018; Plate 6.1A). Agglomerate/conglomerate and breccia. Such rocks are made up entirely of clasts of felsic volcanic/volcaniclastic material (up to 20 cm across seen by the author, but up to 1 m in diameter reported by Davidson and Kowalczyk) (Plate 6.1B). Agglomeratic rocks were noted by Gower (1981) as being most abundant on the west side of the belt, but Davidson and Kowalczyk recorded them as lenses throughout, most commonly in the northern part.

*Other features.* Also observed were anastomosing fractures and joints containing abundant epidote and, locally pyrite. Some of these are uraniferous (*cf.* Sparkes and Davis, 2013).

An additional feature of the supracrustal belt is the abundance of southeast-trending mafic dykes (up to 50% of some outcrops). These show well-defined chilled margins, they may be plagioclase phyric and they include both diabase and gabbro. They explain Stevenson's (1970) incorrect depiction of a large northeast-trending mafic intrusion in the area. Davidson and Kowalczyk (1979) also mention small occurrences of dioritic and granitic rocks.

Rocks examined petrographically cover the range of rock types present, namely crystal–lithic tuffs (AD79-250, CG79-162, CG79-167), lapilli tuff (CG79-024, CG79-019), rhyodacite (CG79-415, CG79-427), rhyolite (CG79-163, CG79-429), agglomerate (CG79-023), and arenite (CG79-018). All contain K-feldspar (mostly microcline), quartz, and an opaque mineral (sulphide in CG79-162 and CG79-163), and most contain plagioclase (not separately identified in some of the rhyolitic rocks) and biotite (orange-brown; some secondary). Actinolitic amphibole is present in CG79-019, CG79-023, CG79-024, CG79-427. Accessory/secondary minerals include apatite, titanite, zircon, allanite, white mica, chlorite, epidote and prehnite. Metamorphic grade is upper greenschist facies. The thin sections show a wide range of flowage and fragmental fabrics that would delight aficionados of felsic volcanic rocks.

### 6.1.2 'LITTLE DOUBLE ISLAND' FELSIC VOLCANIC ROCKS ($P_{2C}$vf/$P_{2C}$gd)

Felsic rocks of possible supracrustal origin occur on an unnamed island 9 km northeast of Burnt Island (dubbed here as 'Little Double Island'). They were first mapped by Gower (1981). The rocks are more metamorphosed than those situated south of Burnt Island, and, although on strike, are unlikely to be directly correlative because the Adlavik

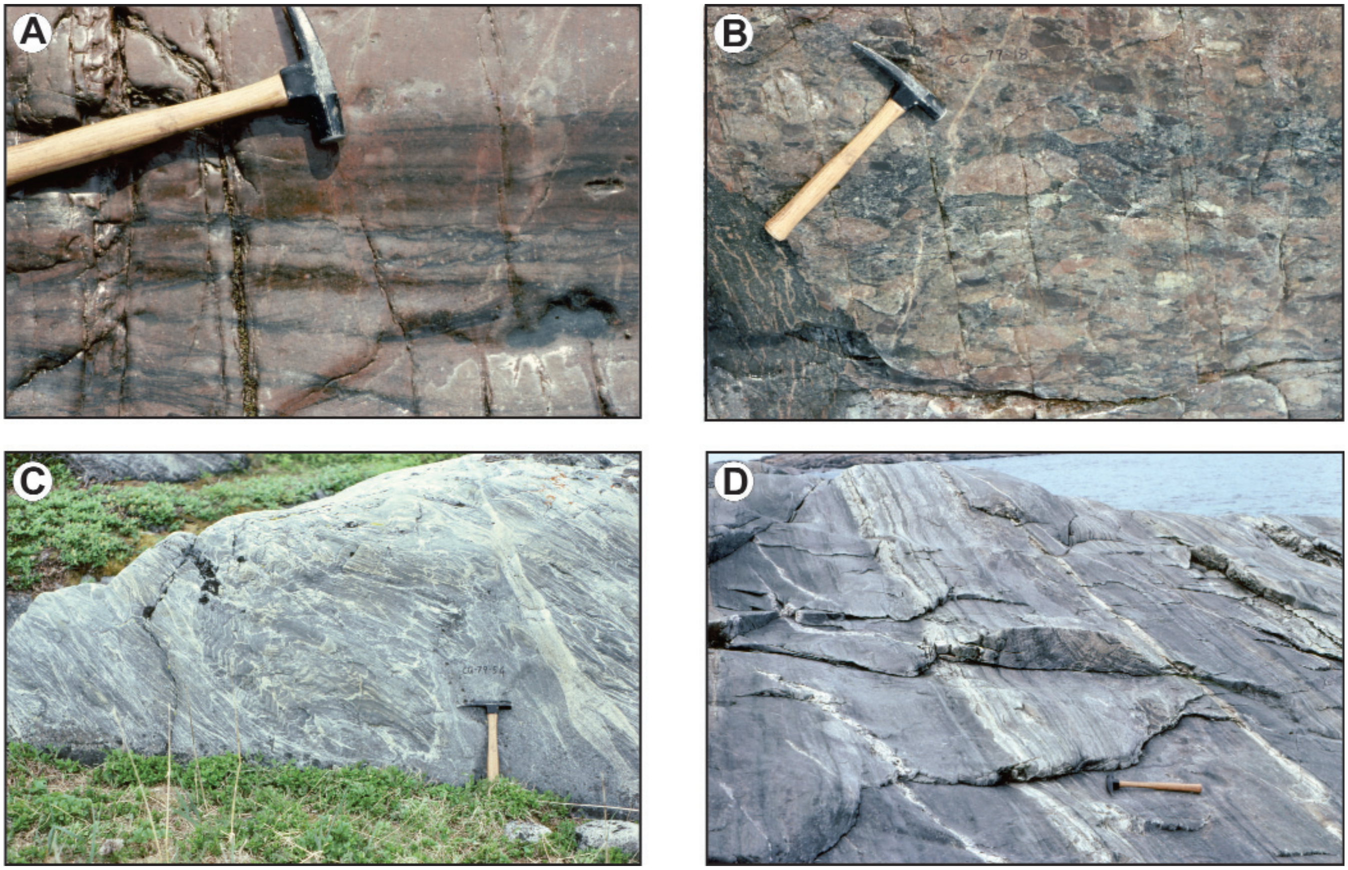


**Plate 6.1.** *Examples of Aillik Group correlative rock types in the Cape Harrison domain (south of Burnt Island, 'Little Double Island', and Double Island areas). A. Crossbedded arkose associated with conglomerate of 6.1B (CG79-018), B. Felsic agglomerate/conglomerate comprising rhyolitic or rhyodacitic clasts, some with quartz or feldspar phenocrysts (CG79-018), C. Fine-grained, banded, migmatitic gneiss, interpreted to have a felsic volcanic protolith (CG79-054), D. Well-bedded quartzite (CG79-073).*

Brook fault passes between the two areas. Gower (field notes) described the rocks as mid-grey-weathering, fine-grained and felsic, having abundant lensy-banded leucosome that looks to be partly the product of *in situ* melting and partly subsequent injection and flattening. The gneissic rocks are also preserved as xenolithic blocks within a more strongly flattened gneissosity developed during a subsequent gneiss-forming event (*e.g.*, CG79-054; Plate 6.1C). The rocks are not unequivocally supracrustal. Epidote-garnet pods, which are a common feature of moderately metamorphosed felsic volcanic/volcaniclastic rocks, are one feature suggesting such a protolith, but it is the fine-grained, heterogeneous nature of the paleosome that particularly encourages interpretation as felsic volcanic. An igneous hypabyssal, or even plutonic, protolith are less favoured alternatives.

A thin section (CG79-054) is best described as a hornblende biotite granodioritic gneissic rock.

### 6.1.3 DOUBLE ISLAND FELSIC VOLCANIC ROCKS ($P_{2C}$vf, $P_{2C}$ss, $P_{2C}$vm)

In contrast to 'Little Double Island', the supracrustal protolith of rocks on Double Island (9 km east of 'Little Double Island') is not in doubt. The rocks are indicated on the maps of Kranck (1953), Christie *et al.* (1953) and Stevenson (1970). In Kranck's (1953) accompanying report, he mentions primary bedded, sheared quartzite in sharp contact with granite and subsequently invaded by granitic veins and correlates them with the Aillik Series farther west. Stevenson (1970, page 7) also gives them mention in his text, describing the rocks as finely banded, dense quartzite. The rocks were mapped in slightly more detail by Davidson and Kowalczyk (1979) and Gower (1981). From the southwest part of Double Island, Ketchum *et al.* (2002; sample 96MKJ-58c) obtained a U–Pb concordant zircon age of 1853 ± 2 Ma from a quartz porphyry that intrudes foliated rhyolite. Sm–Nd isotopic analysis of the same sample yielded $T_{DM}$ = 2041 Ma and $\varepsilon$Nd = +1.62.

Supracrustal rocks present can be subdivided in several groups. The two most common types are, i) fine-grained, sheared, almost gneissic, felsic volcanic/volcaniclastic rocks displaying a heterogeneous, lensy fabric, and, ii) fine-grained, well-bedded (individual layers 1 mm to several centimetres), multicoloured (green, yellow, brown, grey and pink), very siliceous rocks that equate with quartzite previously described by Kranck and Stevenson (Plate 6.1D). Associated with these are fine-grained, massive, structureless siliceous rocks, lacking bedding or banding (possibly intrusive porphyry), and felsic rocks described as 'very brecciated', although it is not clear from field notes whether this is deemed to result from volcanism or deformation. Some, at least, are volcanic as agglomeratic rocks were recorded at data station CG79-078. A dark-weathering, fine-grained, even-textured, apparently concordant amphibolite containing abundant patches of epidote-rich material is present at CG79-066, and may have a mafic volcanic protolith. It contrasts texturally from mafic dykes (at least two generations) that are also common in the area. Epidote (with garnet) is also found in layers, pods and fractures. The felsic volcanic and sedimentary rocks are both pervasively and discordantly injected by minor fine- to medium-grained microgranite intrusions (these also intrude the earlier mafic dykes), and by coarse-grained granitoid plutonic rocks that contain large, stoped blocks of felsic volcanic material.

Four thin sections were examined from the Double Island supracrustal rocks. Three are calc-silicate rocks (CG79-065, CG79-072, SGJ68-145) and one is a felsic volcaniclastic rock (CG79-066B). The calc-silicate rocks, while not a volumetrically significant rock type, do represent an interesting lithological component of the felsic volcanic assemblage. They contain various combinations of plagioclase, K-feldspar, quartz, clinopyroxene, garnet, an opaque oxide, apatite, titanite, epidote and, possibly, vesuvianite (in CG72-072). Epidote is particularly abundant. They are interpreted to have a calcareous clastic protolith metamorphosed to no higher grade than lower amphibolite facies. The remaining sample (CG79-066B) contains plagioclase, K-feldspar, quartz, muscovite, traces of an opaque oxide and minor apatite, and secondary white mica, chlorite and epidote. Heterogeneous grain size and crude stratification justify interpretation as volcaniclastic.

### 6.1.4 TUKIALIK BAY (EAST) FELSIC VOLCANIC ROCKS ($P_{2C}$vf)

The felsic volcanic rocks on the east side of Tukialik Bay underlie an area probably less than 4 km long and about 1.5 km wide, trending in an east-southeast direction. Stevenson, in his field notes recorded "metaquartzite?" at the single helicopter stop (SG68-143) he made in the area, but does not depict supracrustal rocks on his map (Stevenson, 1970). The felsic volcanic rocks were independently recognized during a Placer–Brinex joint mineral exploration program in 1978 (Burns, 1979) and further investigated the following year (Davidson and Kowalczyk, 1979). They were also examined by D. Bailey of the Geological Survey of Newfoundland and Labrador during mapping in 1979 (Gower, 1980, 1981).

Most of the rocks are described in Bailey's field notes as grey, green or pink, fine-grained, structureless equigranular or porphyritic rhyolite that could be intrusive or extrusive. The phenocrysts are feldspar and quartz and vary in size and abundance. Other rock types are rhyolite showing eutaxitic fabric (DB79-267, DB79-274) and ash-flow tuffs displaying well-defined banding. These rocks are intruded by rhyolitic dykes (DB79-266), taken to be cogenetic.

Two thin sections (DB79-264, DB79-274A) shed further light on these rocks. Both are rhyodacitic crystal tuffs, having fragmented plagioclase, K-feldspar and quartz phenocrysts in a moderately flow-banded quartzofeldspathic matrix, with which minor accessory and secondary phases are associated.

### 6.1.5 DEUS CAPE (WEST OF) FELSIC VOLCANIC ROCKS ($P_{2C}$vf/$P_{2C}$sq)

These felsic volcanic and related rocks form a narrow belt less than 1 km wide, extending south for about 6 km from the west side of Deus Cape. Riley's (1951) map shows a small area of supracrustal rocks at Deus Cape that are assigned as 'Aillik Series', but they are not indicated on the maps of Kranck (1953; although Riley was a student of Kranck), Christie *et al.* (1953), or Stevenson (1970). Placer–Brinex exploration geologists were aware of their existence, although outside their joint venture exploration area (Davidson and Kowalczyk, 1979). Their presently depicted distribution relies on the mapping of the author in 1979 (Gower, 1981).

They are buff, grey, green, purple, or pink-weathering, aphanitic to fine-grained felsic pyroclastic rocks exhibiting streaky, lensy textures reflecting their fragmental nature (Plate 6.2A). Their protolith was noted to be particularly clear at CG79-083 where flattened angular clasts up to 10 by 2 cm were recorded. Some of the rocks were described as being flaggy and very siliceous, and possibly derived from quartzite. Locally, strongly schistose, fine-grained amphibolite (mafic volcanic rock?) is associated. A key characteristic is that the rocks are much more strongly deformed and metamorphosed than those seen farther west, although some of the rocks on Double Island are similar. The deformation and metamorphism was accompanied by agmatitic migmatization due to heavy injection by fine-grained felsic material. Some of the streakiness may be due to deformed granitic segregations, rather than primary pyroclastic material.

Any doubts regarding their volcaniclastic protolith are dispelled petrographically, despite thorough recrystallization and strong deformation (CG79-080, CG79-081B, CG79-083). Grain size variation, crude stratification and a mottled aspect, due to recrystallized clusters of various felsic (plagioclase, microcline/perthite, quartz) and

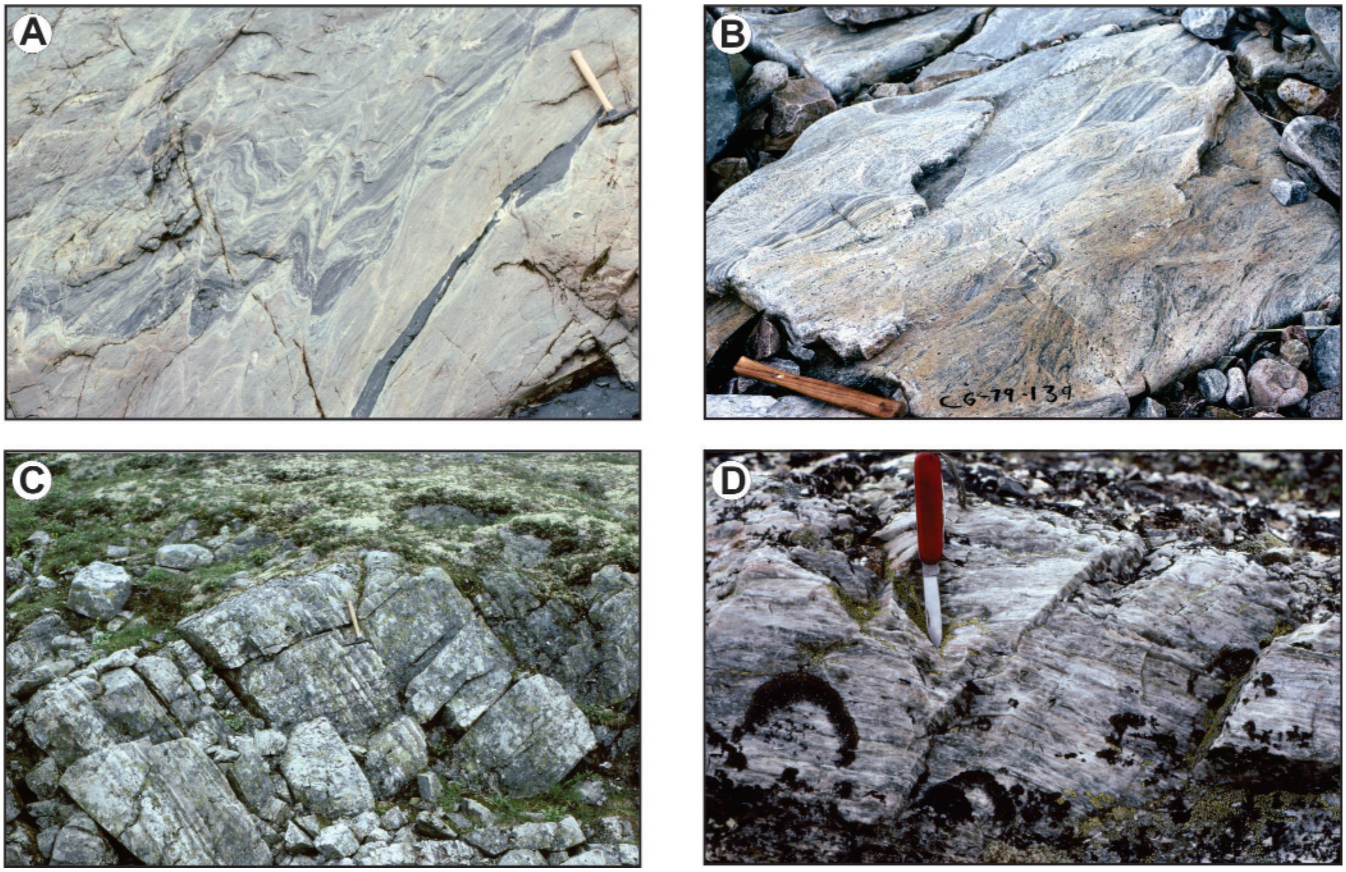


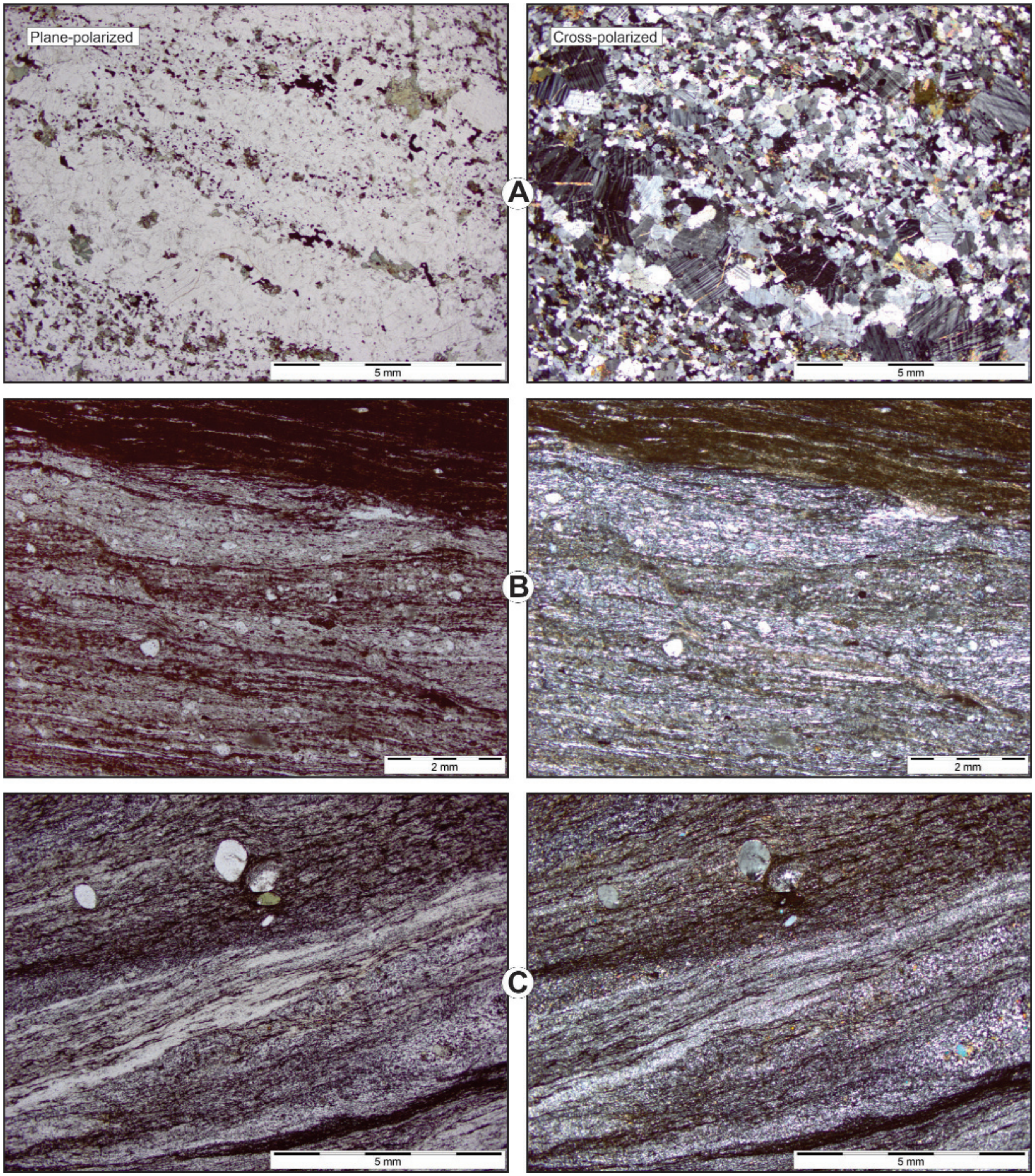
**Plate 6.2.** *Examples of Aillik Group correlative rock types in the Cape Harrison domain (Deus Cape, Cape Harrison, and Tessialuk Lake areas). A. Fine-grained, banded felsic rocks, interpreted to be volcanic. Intruded by microgranite dyke (bottom/right), and thin mafic dyke (CG79-080), B. Schlieric banded and migmatitic quartzofeldspathic rock that may have been derived from a felsic volcanic protolith (CG79-139), C. Well-bedded volcanogenic sediments (AD79-261), D. Mylonitized, fine-grained, banded siliceous rocks, interpreted to be derived from felsic volcanic rocks (AD79-304).*

mafic (olive-green biotite, actinolite) minerals testify in favour of former fragmental fabrics (especially evident in CG79-083; Photomicrograph 6.1A). Accessory minerals are an opaque oxide, apatite, titanite, white mica, chlorite and epidote. Metamorphic grade is, at most, lower amphibolite facies.

### 6.1.6 CAPE HARRISON METAMORPHIC SUITE FELSIC VOLCANIC ROCKS ($P_{2C}$vf/$P_{2C}$gd)

The claim that felsic volcanic rocks are associated with the Cape Harrison Metamorphic Suite is based on the observations of Gower (1981). The rocks have also been investigated by Ketchum (1998) and Ketchum *et al.* (2002). The rocks lack any obvious signs of primary origin, so interpreting them to be felsic volcanic/subvolcanic remnants is somewhat speculative, but not, so far, controversial. For example, Stevenson (1970, field notes) described the rocks as "granitized, dirty gray, quartzitic gneisses" or "feldspathized dirty metaquartzite", and Ketchum *et al.* (2002) concurred that these rocks were "felsic and siliceous rocks of possible supracrustal origin" (although they show the same rocks on their map as leucogranodiorite gneiss). The rocks lack associated supracrustal rock types for which protolith commonly can be readily identified (*e.g.*, marble, pelite, quartzite, mafic volcanic rocks).

The rocks occur as diffusely to sharply bounded enclaves, which vary considerably in size (centimetres to kilometres) and abundance. They are green, yellow and buff, fine- to medium-grained, silica-rich, quartzofeldspathic rocks characterized by very lensy, slivery, streaky or schlieric fabrics (Plate 6.2B). Some larger-than-groundmass quartz and feldspar crystals hint at porphyry protoliths, and diffuse layering (defined by mineral or grainsize variations) could be evidence of former primary igneous flowage or bedding. The rocks typically have quartzofeldspathic segregations or are heavily injected by granitic veins. A wide range of agmatitic to nebulitic fabrics is represented. Although the rocks are migmatitic, the metamorphic grade is relatively modest, being no higher than middle amphibolite facies. Melting was probably incipient to moderate, rather than



**Photomicrograph 6.1.** *Aillik Group correlatives in the Cape Harrison domain, Makkovik Province, and mylonitic rocks that may superficially resemble them. A. Deus Cape fragmental felsic volcanic rock (CG79-083), B. Mylonitic rock inferred, from field context, to have a felsic volcanic protolith (SG68-119), C. Mylonitic rock, for which, from field context, a felsic volcanic or a felsic plutonic protolith are plausible (DB79-224A).*

advanced. Other features include: i) diffuse skialiths of biotite-rich material, ii) blocks or layers of amphibolite, commonly injected by abundant granitoid veins, and iii) calcareous garnet-bearing pods. The common presence of calc-silicate pods (CG79-127, CG79-134, CG79-141, CG79-187), is regarded as evidence in favour of a supracrustal origin, as such pods are a consistent feature of more readily identifiable felsic volcanic and associated rocks elsewhere in the Cape Harrison domain.

A thin section of a calc-silicate pod (CG79-187B) contains quartz, altered diopside (?), garnet (*cf.* grossularite), epidote and carbonate, plus trivial amounts of actinolite and allanite (no feldspar). Some of the rocks in thin section display heterogeneity of fabric that suggests either a volcanic protolith, and/or former porphyry texture (CG79-142A, CG79-145, CG79-187A, CG79-225B, CG79-493, CG79-500). In one of these (CG79-187A), zircon is unusually abundant and euhedral (making it viable to date as a possible Aillik Group correlative). Its probable volcanic protolith is supported by association in outcrop with 50 by 30 cm pods of calc-silicate rock.

### 6.1.7 TESSIALUK POND FELSIC VOLCANIC ROCKS ($P_{2C}$vf, $P_{2C}$vp)

The Tessialuk Pond felsic volcanic belt (informal new name) is situated along the south side of the Benedict Mountains. The belt is 34 km long and up to 1.5 km wide and strikes due east. It takes its name from Tessialuk Pond, which is also referred to in various early reports as ‘J (or Jay) Lake’, because of its shape. Part of the Tessialuk Pond felsic volcanic rocks were discovered during Placer–Brinex mineral exploration activities. No mention of them is made by Burns (1979) based on his 1978 reconnaissance mapping, so it seems likely that they were found during follow-up mapping in 1979 (Davidson and Kowalczyk, 1979). In their report, they mention that they traced the belt to its eastern end 10 km beyond their concession’s boundary. The same belt of rocks was also independently mapped by the Geological Survey of Newfoundland and Labrador (later?) in the same year (Gower, 1980, 1981). Stevenson (1970) does not show felsic volcanic rocks in this area on his map, but he initially identified ‘argillite and quartzite’ and speculated on their correlation with the Aillik Group (field notes SG68-119, SG68-120). He, reasonably, settled on interpreting the rocks as mylonite.

No geochronological information is available, so it is an assumption that the rocks are correlative with the Aillik Group. Given their anomalous easterly trend, in contrast to all other occurrences, it is possible that the rocks are Labradorian rather than Makkovikian (but this trend could have been imposed during Grenvillian deformation).

The rocks are rhyolitic to dacitic, pink, red, grey, green, or buff-weathering, aphanitic to fine grained, and commonly have a hackly fractured appearance. They include a wide variety of felsic crystal–lithic tuffs having a streaky lamination due to flow banding. Both ash-flow and ash-fall tuffs were identified in the field. Also present are well-bedded, and partly sorted volcanogenic sediments (*e.g.*, CG79-692, AD79-261; Plate 6.2C). Unsorted breccia occurs in the eastern part of the belt, containing angular fragments of quartz-feldspar rhyolite porphyry and fine-grained, non-porphyritic dacite in a poorly sorted dacitic matrix (AD79-261). Rhyolitic flows and porphyry intrusions were also recorded, some having feldspar phenocrysts up to 2 cm long. There are a few examples of very fine-grained mafic to intermediate rocks, interpreted to be flows. Mafic dykes and sills are also present, and the rocks are injected by microgranite and quartz veins. The assemblage is commonly strongly to intensely sheared, especially where close to its southern boundary, which is interpreted to be a thrust.

Thin sections prepared from the belt (AD79-261, AD79-262A, AD79-265, AD79-286, AD79-304, AD79-305A, AD79-305B, CG79-442, CG79-454, CG79-479, CG79-700, CG79-709, N68-064, SG68-119B, SG68-226) are mostly crystal–lithic tuffaceous rocks, although a few were labelled as rhyodacite porphyries or tuffaceous sediment. The minerals present are typical of felsic volcanic rocks, comprising phenocrysts and porphyroclasts of plagioclase, K-feldspar and quartz in a fine-grained quartzofeldspathic matrix associated with secondary or metamorphic biotite, actinolite (in CG79-700, CG79-709, SG68-226), an opaque oxide, and sporadically present apatite, titanite, allanite, fluorite (in CG79-479), white mica, chlorite, epidote and prehnite). The feature of major interest is that the rocks display spectacular high-strain fabrics (*e.g.*, porphyroclast rotation, stair-step structures). It is a challenge to decide whether this is the product of igneous flowage or mylonitic deformation. Undoubtedly mylonitic deformation is pervasive and severe (Plate 6.2D). The very straight, extremely thin laminae displayed in Stevenson’s thin section SG68-119B, for example, is a classic example of ultramylonitization (Photomicrograph 6.1B). Not all rocks are severely deformed, however, and any thought that mylonitization has completely disguised the protolith and that the rocks are not felsic volcanic can be dismissed.

### 6.1.8 WEST OF BYRON BAY ($P_{2C}$vf)

A small area of fine-grained rocks (4 by 1.5 km, elongate in a southeast direction) was discovered by D. Bailey of the Geological Survey of Newfoundland and Labrador during mapping in 1979 (Gower, 1981) and were mapped as felsic volcanic rocks. He described them as being white, cream, pink, grey and green-weathering, fine grained, laminated or banded, recrystallized, and locally porphyritic, and having rhyodacitic to rhyolitic compositions. Some intercalated, fine-grained, mafic, porphyritic rock is associated. The assemblage was interpreted to have been derived mostly from tuffaceous sedimentary rocks, but possibly to include mafic and felsic flows.

Three thin sections are available (DB79-224A, DB79-224B, DB79-250B); all are thoroughly recrystallized and deformed fine-grained quartzofeldspathic rocks. One of them is an ultramylonite (DB79-224B; Photomicrograph 6.1C) having near-circular quartz and K-feldspar porphyroclasts. The other two have heterogeneous grain-size variation, and are less strongly deformed.

The author has not seen the rocks in the field and has adopted D. Bailey's protolith interpretation of the rocks, but not without some doubts that can only be resolved by more detailed investigation. To be kept in mind are the following: i) that the rocks are in a region of recrystallized granitoid rocks south of the Benedict fault that has been affected by Grenvillian deformation and metamorphism, and ii) petrographic evidence is inconclusive regarding the protolith, but is conclusive regarding imposed severe deformation. Could they be mylonitized granitoid rocks?

### 6.1.9 AILLIK GROUP MISCELLANEOUS

Apart from the above-described areas, there are various minor occurrences in the Cape Harrison domain, and rocks in the northernmost Grenville Province, south of the Cape Harrison domain that are probably correlative. Knowledge of them is typically based on single outcrops in areas otherwise lacking in outcrop, or from enclaves in granitoid rocks. Few of them are likely to be extensive, but such cannot be universally assumed. If the quest is for felsic volcanic rocks, they may point the way to new discoveries. A few examples are as follows (all outside the area of Figure 6.2):

i) In the southeast part of White Bear Bight a single outcrop of green, fine-grained mafic to intermediate volcanogenic sediment (AL78-141) may be a septum between the Stag Bay and Big River granitoid bodies;
ii) Supracrustal rocks may be associated with the White Bear Lake granitoid rocks and, along with other hints, may indicate a small felsic volcanic belt in that area (*e.g.*, SG68-304);
iii) In various places an alternate plutonic/volcanic designator has been used (especially in the Cape Harrison Metamorphic Suite – CHMS);
iv) In the Smokey area (White Bear Islands granulite complex) pelitic sediments may be time equivalents of the Aillik Group.

Further mention of these examples is given later in the report where the above- mentioned units are described.

## 6.2 SYN- TO LATE-MAKKOVIKIAN GRANITOID ROCKS (1840–1820 Ma)

### 6.2.1 DEUS CAPE GRANITOID ROCKS ($P_{2C}$gp)

The Deus Cape granitoid unit (Figure 6.3; Appendix 2, Slab images 6.2) was mapped by Gower (1981; part of his Unit 19) and named by Kerr (1989a, 1994). It was not separately distinguished from other granitoid units in the region by Kranck (1953) or Stevenson (1970), although Stevenson's field notes imply that he recognized it was different from the surrounding rocks.

A foliated biotite monzogranite from the Deus Cape granitoid unit has been dated by Kerr *et al.* (1992; sample GSZ-3). Based on three multigrain fractions, it has a U–Pb, 6–10% discordant zircon age of 1837 +12/–8 Ma. The age is anomalously old, in that the unit lacks the migmatitic fabrics present in the adjacent CHMS. If the contact between the two units is intrusive (but not rejecting that it could be structural), the absence of migmatization, most straightforwardly, implies that the Deus Cape unit is younger, yet gneissic rocks from the CHMS have yielded three analytically identical ages of 1815 Ma (Ketchum *et al.*, 2002). There is no justification for dismissing the 1837 Ma age, inasmuch as it falls between other felsic magmatic events in the region at 1855 and 1815 Ma. Nevertheless, given that the date is anomalous, that fractions were multigrain and that the results were discordant, there are certainly grounds for seek-

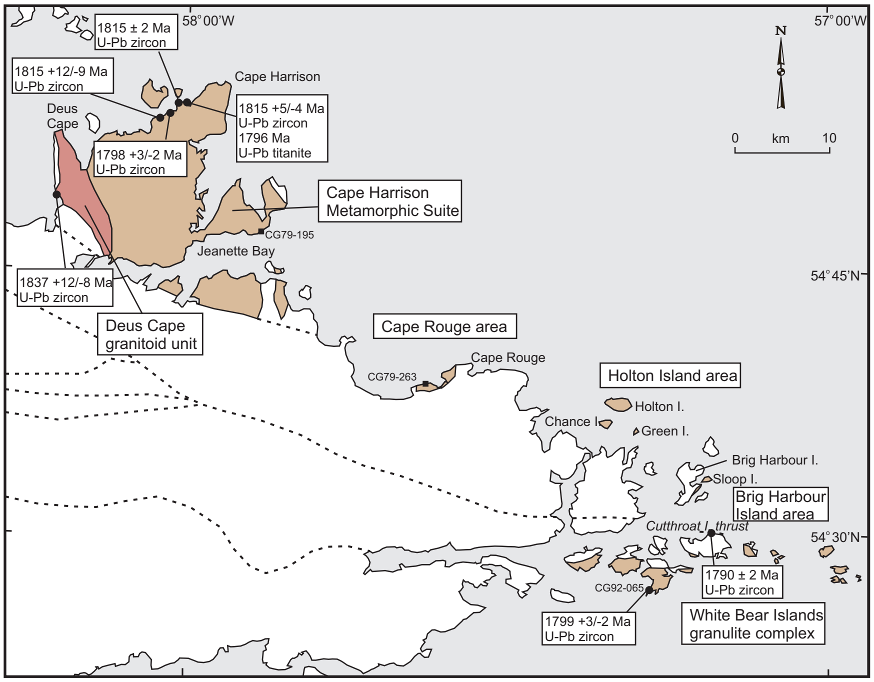


**Figure 6.3.** *Distribution of Cape Harrison Metamorphic Suite and potentially correlative rocks.*

ing confirmation by further investigation. The geochronology sample has also yielded a Sm–Nd $T_{DM}$ value of 1954 Ma and εNd = +2.63, recalculated for 1837 Ma from Kerr and Fryer's (1994) assumed 1850 Ma age.

This author's field notes for the unit suggest that more than one rock type is present. He noted: i) pink, coarse-grained, moderately foliated granodiorite, containing large K-feldspar crystals and hosting abundant enclaves of 'Aillik Group' felsic material, ii) pink to buff, coarse-grained, strongly foliated granodiorite, iii) pale-grey to pinkish, medium- to coarse-grained, foliated seriate to megacrystic granodiorite with euhedral zoned K-feldspar megacrysts up to 5 by 2 cm, and iv) dark-grey, medium-grained, strongly foliated biotite granodiorite with abundant streaks of quartzofeldspathic segregations. Note that these are all rather similar rock types, so may indicate no more than moderate variation within a single magma. The rocks also contain irregular patches of pegmatoidal material and more distinctly vein-like granite. They are also intruded by net-veined mafic dykes, which are, in turn, intruded by pegmatite.

> Three thin sections (CG79-121, CG79-494, SG68-152) are all very similar, consisting of relict igneous and metamorphic plagioclase (moderately zoned and displaying saussuritized cores), K-feldspar (seriate; microcline and minor perthite; plagioclase inclusions), quartz, olive-green biotite, an opaque oxide, apatite, titanite (multiple growth stages and mantling an opaque mineral), zircon, allanite (cores to epidote), and secondary chlorite and white mica. Apart from lacking amphibole, the rocks are rather similar to those in the CHMS. They are also similar to the Stag Bay granodiorite (Gower, 1981), foreshadowing a suggestion (*see* Chapter 20 – Structure) that, prior to faulting, the Deus Cape and Stag Bay bodies could once have been much closer. A net-veined mafic dyke intruding Deus Cape granitoid was also examined in thin section (CG79-119C). It is an amphibolite carrying relict igneous clinopyroxene. Although mostly recrystallized, some vestiges of subophitic texture remain.

## 6.3 LATE MAKKOVIKIAN (1820–1800 Ma)

### 6.3.1 CAPE HARRISON METAMORPHIC SUITE ($P_{2C}$gd, $P_{2C}$gp, $P_{2C}$gr, $P_{2C}$mz)

The CHMS was mapped and named by Gower (1981) for a group of gneissic quartzofeldspathic rocks derived from igneous protoliths underlying a 20 x 20 km peninsula north of Jeanette Bay (Figure 6.3; Appendix 2, Slab images 6.2). Similar rocks on the south side of Jeanette Bay are also included as part of the suite. None of these rocks were separately distinguished by Kranck (1953) or Stevenson (1970) from other granitoid rocks in the region, and the CHMS was not included in the investigations of Kerr (1989a, b, 1994), apart from reporting Nd isotopic results for two samples. The most detailed studies to date (addressing the northern part of the CHMS) were carried out by Ketchum (1998) and Ketchum *et al.* (2002).

The age of the CHMS has been reliably established by Ketchum *et al.* (2002), who reported ages for four samples. Migmatitic leucogranodiorite gneiss (sample MKJ-1a) has an age of 1815 +12/–9 Ma, based on 6 multigrain zircon fractions. A large tonalite gneiss xenolith (96MKJ-56) hosted by megacrystic granite was dated to be 1815 ± 2 Ma, based on three zircon concordant/near-concordant fractions (one single, two multigrain) of seven analyzed fractions. The four remaining fractions plot to the left of the Pb-loss line. A foliated homogeneous tonalite (96MKJ-55a) has an age of 1815 +5/–4 Ma, based on four near-concordant zircon fractions (three single, one multigrain). This sample also yielded a concordant titanite age of 1796 Ma (error not reported, but small). In contrast to these analytically identical ages, weakly foliated K-feldspar megacrystic granite has a younger age of 1798 +3/–2 Ma, based on four multigrain zircon fractions. The CHMS has also been dated by Rb–Sr whole-rock methods (Brooks, 1982a). A regression of eight samples gave an errorchron result of 1740 ± 85 Ma, $I_{Sr}$ = 0.7034.

Sm–Nd data for the CHMS have been previously reported by Kerr and Fryer (1994), and by Ketchum *et al.* (2002), and are now augmented by results from Moumblow (2014). Note that the data from Kerr and Fryer (1994) have been recalculated for an emplacement age of 1815 Ma, rather than the 1850 Ma originally used. Data are fairly consistent, having $T_{DM}$ = 1.95 to 2.10 Ga and εNd = –0.1 to +2.4, excluding the 1798 Ma megacrystic granodiorite, which has values of $T_{DM}$ = 2.2 Ga and εNd = –1.5.

As concluded by Ketchum *et al.* (2002), the U–Pb results indicate tonalite and granodiorite plutonism and gneissic fabric development all occurred at 1815 Ma. The Sm–Nd results rule out the presence of Archean crust, and are consistent with the development of the CHMS at the root of a juvenile magmatic arc (Kerr and Fryer, 1994; Ketchum *et al.*, 2002). The anomalous Sm–Nd result for the megacrystic granodiorite suggests the involvement of older crust, although not necessarily Archean (Ketchum *et al.*, 2002). Furthermore, note that the Nd isotopic characteristics are different from those of the Deus Cape granitoid (also megacrystic), which has $T_{DM}$ = 1954 Ma and εNd = +2.63, hence denying correlation, if data are representative for the two units. The nominal 1740 Ma Rb–Sr date is in agreement with regional evidence for a post-Makkovikian disturbance.

In the field, a key aspect of the CHMS is its wide variety (in terms of grain size, texture, fabric and composition) within the context that they are, overall, rather ordinary granitoid rock types. A quartz–alkali-feldspar–plagioclase plot presented by Ketchum (1998) classifies most of the rocks as granodiorite and granite (Type 3b), with spillover into the fields for quartz monzonite, and, rarely, quartz diorite and tonalite. Despite previous descriptions emphasizing tonalitic rocks (Gower, 1981; Ketchum *et al.*, 2002), such rocks are not dominant, based on stained slabs (Appendix 2, Slabs 6.2) and thin sections. The rocks are subdivided here into: i) possible felsic volcanic/subvolcanic remnants (addressed in Section 6.1.6), ii) granodioritic and quartz monzodioritic rocks, and iii) granitic and quartz monzonitic rocks.

The granodioritic (partly quartz monzodioritic) rocks are light- to dark-grey weathering, medium to coarse grained, and massive to strongly foliated. They vary from migmatitic to homogeneous, showing some evidence that the homogeneous varieties postdate the migmatitic types. They are also characterized by amphibolite blocks, biotite-rich schlieren, near-amorphous clots of hornblende-bearing mafic material, incipient to extensive leucosome segregation, and enclaves of migmatitic granitoid rock that are, themselves, within a migmatitic host (Plate 6.3A). Larger-than-groundmass feldspar crystals may imply porphyry origin, hence genetic continuum with the felsic volcanic remnants, but porphyroblastesis is an alternative possibility. The rocks are locally heavily injected with white, buff-yellow, or pink aplitic and granitic material.

The granitic (partly quartz monzonite, and rarely quartz syenite or alkali-feldspar granite) rocks are grey or pink-weathering, medium or coarse grained, and massive to weakly foliated. They mostly postdate the granodioritic rocks, with the caveat that the polyphase nature of the CHMS inevitably means that such is not universally true. A sub-group of these rocks are K-feldspar seriate to megacrystic. The K-feldspar megacrystic are typically of fairly normal size (2 by 1 cm), but, south of Jeanette Bay (*e.g.*, CG79-187), some megacrysts reach 7 by 5 cm (belonging to an unrelated unit?). Both non-megacrystic and megacrystic granitoid rocks contain rafts of earlier gneissic granitoid rocks, mafic enclaves and biotitic schlieren. The rocks are intruded by a variety of minor microgranite and pegmatite intrusions. These intrusions both predate and postdate mafic dykes, which are very common. These diabase and gabbroic dykes include both net-veined and homogeneous types. Some of the mafic dykes are near-horizontal and could be allied with the Kokkervik dykes in the western Makkovik Province.

Of the 26 thin sections of CHMS examined, two were termed tonalite (CG79-246, CG79-500), four, monzodiorite (CG79-196, CG79-198A, CG79-225B, CG79-244), two, quartz monzonite (CG79-142B, CG79-207), ten, granodiorite (CG79-130, CG79-142A, CG79-145, CG79-180, CG79-216A, CG79-242, CG79-251, CG79-493, CG79-499, CG79-503), and eight, granite (CG79-151, CG79-187A, CG79-201, CG79-204, CG79-208, CG79-225A, CG79-229, CG79-505). Although mineral proportions vary, there is an overall consistency between samples in mineral assemblages and their petrographic details, hence collective description is given. All contain relict igneous or metamorphic plagioclase (typically moderately zoned and displaying saussuritized cores), K-feldspar (microcline and perthite; megacrystic in part), and quartz. Olive-green biotite is also present in all thin sections, except three, in which it has been entirely chloritized. Blue-green hornblende is found in about half of the samples, and is partly relict, having been pseudomorphed by biotite, epidote, titanite, quartz and opaque minerals. Accessory minerals include an opaque oxide (sulphide also present in four samples), apatite, zircon, titanite (typically mantling the opaque oxide), allanite, epidote, white mica and chlorite (after biotite). Allanite is unusually large and distinctly rimmed in CG79-151 and CG79-180. Titanite is also unusually large in CG79-180. Garnet was recorded sporadically in field notes, but not seen in any thin section.

### 6.3.2 CAPE HARRISON METAMORPHIC SUITE CORRELATIVES? ($P_{2C}$gd, $P_{2C}$gr)

Gneissic rocks assigned here as Cape Harrison Metamorphic Suite correlatives are located in three areas at the eastern end of the Cape Harrison domain, namely Cape Rouge, Holton Island and the east side of Brig Harbour Island (Figure 6.3). The rocks were mapped by Gower (1981) and Owen (1985), although not all the rocks in the

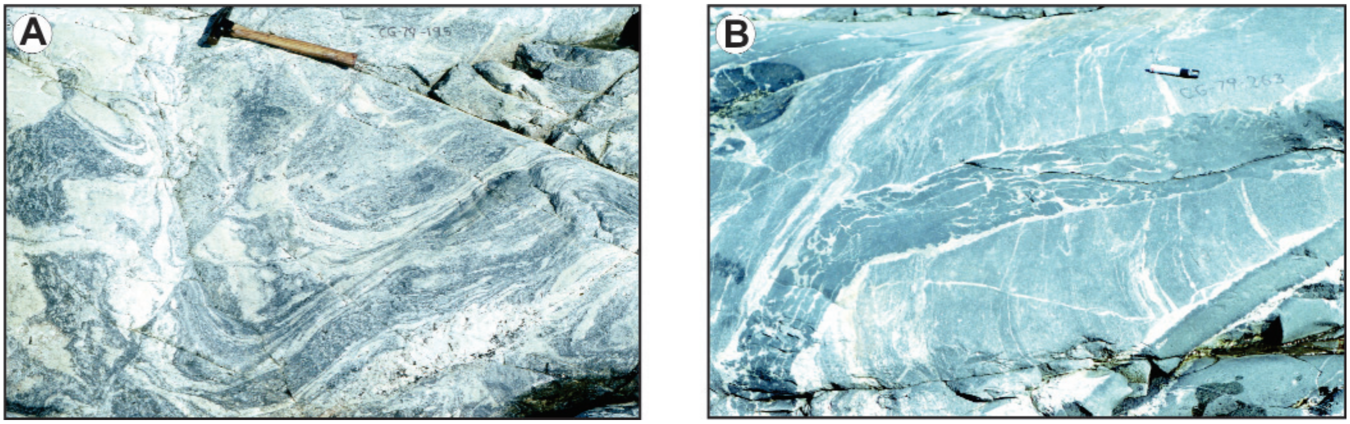


**Plate 6.3.** *Examples of tonalite–granodiorite migmatitic gneiss of the Cape Harrison Metamorphic Suite and potential correlatives. A. Cape Harrison Metamorphic Suite migmatitic tonalite–granodiorite gneiss (CG79-195), B. Cape Rouge area tonalite–granodiorite gneiss, intruded by net veined mafic dykes with leucosome margins (CG79-263).*

three areas were assigned identically. Owen (1985) and Owen *et al.* (1988) also correlated these rocks with the White Bear Islands granulite complex, which is addressed in the next section.

The emplacement age of these rocks is uncertain, thus also their affinity with the CHMS. Owen (1985) and Owen *et al.* (1988) included Rb–Sr data for a sample from a large xenolith of dioritic gneiss (sample V-774) within biotite granite at Cape Rouge in an eight-point Rb–Sr whole-rock regression for the White Bear Islands granulite complex (Owen's Unit 2). This gave an errorchron date of 1923 ± 148 Ma, $I_{Sr}$ = 0.7026. Owen *et al.* (1988) also reported Ar–Ar dates for the same sample. From hornblende, a total-gas age of 1647 ± 2 Ma was obtained and complemented by biotite total -gas and plateau ages of 1589 ± 2 Ma and 1595 ±2 Ma, respectively. From Green Island, a K-feldspar megacrystic granodiorite gave hornblende and biotite total-gas ages of 1661 ± 2 Ma and 1507 ± 2 Ma, respectively, but, in this case, it is likely that the sample (V-766) came from a post-gneiss unit, although gneissic rocks are also present on the island. It is clear, from other geochronological results obtained in the area, that the Ar–Ar dates reflect mid-Labradorian and post-Labradorian disturbance, rather than time of emplacement (*see* WBIGC, next section).

In the Cape Rouge area, Gower depicts (2010a; Bryon Bay map region) a 5 by 1.5 km area of gneissic granodiorite, but the reality is much more complex. The rocks are characterized by abundant rafts of migmatite in diorite, quartz diorite, quartz monzonite and minor tonalite host rocks. The migmatite has blocks of mafic rock and more diffuse biotitic schlieren associated with common leucosome. Both the gneiss and its host have north-northeast-trending fabrics, typical of Makkovikian deformation. These rocks are intruded by microgranite, then net-veined mafic dykes (at least two phases; Plate 6.3B), and later granitoid dykes.

Farther east, on Holton Island and two smaller islands immediately south (Chance Island and Green Island), the rocks are complex assemblages of migmatitic, poorly to well-banded tonalite/granodiorite (having quartzofeldspathic leucosomes carrying large hornblende crystals), amphibolite, and various lensy, deformed, grey to yellowish, fine-grained felsic rocks of possible volcanic origin. All have been agmatitically injected by other foliated to massive granitoid rocks and net-veined mafic dykes, intruded, in turn, by non-net-veined mafic dykes.

The east side of Brig Harbour Island and Sloop Island farther east have grey, fine- to medium-grained, strongly foliated to gneissic tonalite/granodiorite associated with amphibolite and both injected by white leucosome. These rocks are intruded by K-feldspar megacrystic quartz monzodiorite to granodiorite, which Owen (1985) depicted as the dominant unit (as it might well be).

> Two thin sections from the Cape Rouge area are diorite (CG79-263A) and granite (CG79-263B). Both rocks are extensively recrystallized and have a well-defined foliation, clearly indicating strong deformation. Minerals present in both are plagioclase, K-feldspar (microcline and perthite), quartz, orange-brown to olive-green biotite, dark-green hornblende, an opaque oxide, apatite, and titanite (mantling opaque mineral). Apatite in the diorite is unusually abundant. The granite, in addition, has zircon, epidote, allanite (showing multiple growth stages) and fluorite. One thin section from the east side of Brig Harbour Island (CG79-312) is also recrystallized and strongly foliated. It is granite, having a mineral assemblage similar to the sample from Cape Rouge, except lacking amphibole and allanite. It contains fluorite.

### 6.3.3 WHITE BEAR ISLANDS GRANULITE COMPLEX ($P_{2C}$gd, $P_{2C}$gp, $P_{2C}$gr, $P_{2C}$mz, $P_{2C}$dr)

The White Bear Islands granulite complex (WBIGC; Figure 6.3) is in an area mapped by Gower (1981), but it was first recognized as an independent entity, and named, by Owen (1985). The rocks were not distinguished from their surrounding rocks by Kranck (1953), but were by Stevenson (1970), who established the position of the Grenville front in the area (currently positioned at the Cutthroat Island thrust). By so doing, he separated granitoid gneiss of the WBIGC in the Grenville Province from mostly fairly weakly deformed granitoid rocks in the Makkovik Province (Stevenson's units 6 and 7, respectively).

Despite having crossed, what has traditionally been considered to be, a major tectonic boundary, there is good justification for grouping the WBIGC with other mid- to late-Makkovikian gneissic rocks. One excellent reason is their U–Pb age. A date of 1799 +3/–2 Ma from migmatized granodioritic gneiss (sample CG92-065A) was obtained by Krogh *et al.* (2002), based on three multigrain, near-concordant/discordant zircon fractions. That the gneissosity is not the product of later orogenesis is demonstrated by younger crosscutting units, namely two phases of mafic dykes (early, migmatized dykes and later, unmigmatized dykes), themselves intruded by an aplitic dyke, which was dated to be 1647 +7/–5 Ma, based on five multigrain zircon fractions (Plate 6.4A–D). Concordant single-zircon ages of 1793 ± 2 Ma and 1733 ± 10 Ma were obtained from the unmigmatized mafic dyke, but the preferred interpretation was that the zircons are xenocrystic (Krogh *et al.*, 2002). From a second site, an age of 1790 ± 2 Ma, on a single concordant zircon from a felsic mylonite (sample CG92-066C), provides a minimum age for the mylonite's precursor. A weakly deformed pegmatite postdating mylonitic deformation from the same site yielded an age of 1730 ± 2 Ma, based on two single concordant zircon analyses (Krogh *et al.*, 2002).

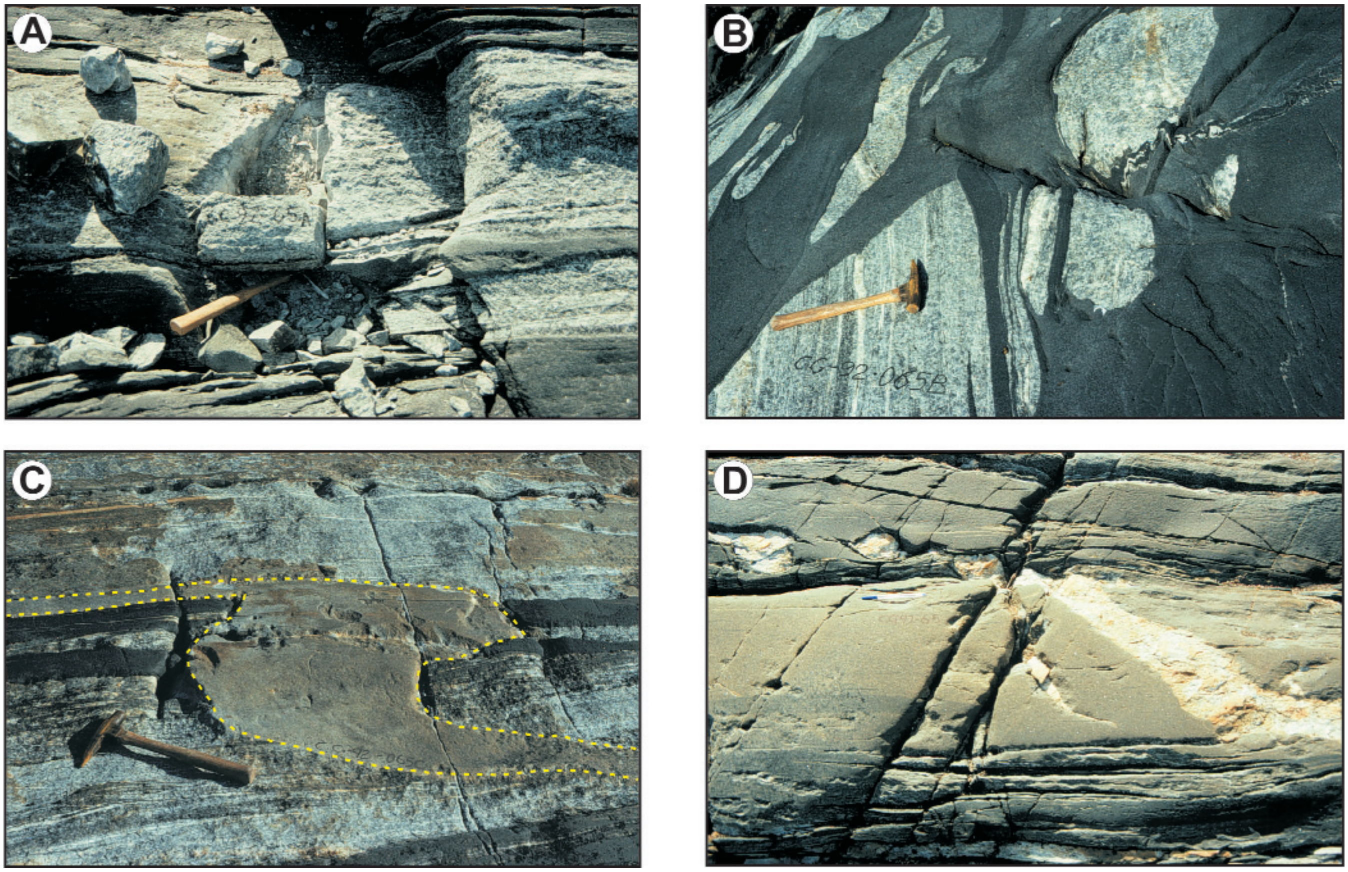


**Plate 6.4.** *White Bear Islands granulite complex granodiorite gneiss at dated locality (also showing crosscutting later mafic and felsic dykes). Modified from Krogh* et al. *(2002). A. Granodiorite gneiss dated to be 1799 +3/-2 Ma (CG92-065A), B. Grey mafic dykes intruded by black mafic dykes (CG92-065B), both discordantly intruding 1799 Ma granodiorite gneiss, C. Buff-grey aplite dated to be 1647 +7/-5 M (CG92-065C), discordantly intruding host granodiorite gneiss (border enhanched), D. Pegmatite (CG92-065D), discordantly intruding buff-grey aplite, but itself deformed and boudinaged outside aplite.*

The U–Pb ages provide endorsement for earlier, imprecise Rb–Sr whole-rock geochronological data from the WBIGC obtained by Owen (1985) and Owen *et al.* (1988). A dioritic gneiss (Owen's Unit 2) yielded an eight-point errorchron of 1923 ± 148 Ma, $I_{Sr}$ = 0.7026, and a jotunitic gneiss (Owen's Unit 3A) gave an eight-point errorchron of 1899 ± 187 Ma, $I_{Sr}$ = 0.7028. Further constraint for the minimum time of gneiss formation comes from a crosscutting granodiorite unit that has an eight-point isochron/errorchron age of 1787 ± 35 Ma, $I_{Sr}$ = 0.70233.

To be kept in mind is that the U–Pb geochronological data suggest that, despite addressing the WBIGC at this juncture (because of similarity to other units in this section), the migmatizing and deformational event that affected the WBIGC was about 15 million years younger than that which affected the CHMS. Instead, it was coeval with the late- to post-Makkovikian events addressed in the next section.

The granodioritic gneiss sample CG92-065A has also given a Sm–Nd $T_{DM}$ value of 1992 Ma, εNd = + 0.75 (R. Creaser, personal communication, 1999), and three other samples from the WGIBC, for which no dates are available but calculated for 1815 Ma, have $T_{DM}$ values of 1976 to 2105 Ma and εNd = +0.39 to +1.35 (Moumblow, 2014).

Field description of the WBIGC is based on Owen (1985), with a few details added from the author's own observations. Owen subdivided the WBIGC into four units, namely: i) metasedimentary gneiss (his Unit 1), which is addressed in Section 7.3.1.8, ii) dioritic, quartz dioritic and minor tonalitic gneiss (Unit 2), iii) jotunitic to charnockitic gneiss (Unit 3), and iv) pyroxene monzonitic gneiss (Unit 4). The dioritic to tonalitic gneiss is characterized by a simple melanocratic–leucocratic banding, which has been infiltrated by medium-grained leucosome. Some leucosome is host to large hornblende crystals. Typically, these gneisses are very well banded and have associated biotite hornblende amphibolitic lenses. The rocks are intruded by now-deformed pegmatite dykes, subsequently intruded by various mafic dyke phases. In contrast, the jotunitic to charnockitic gneiss is more commonly foliated than gneissic, having fabric defined by oriented feldspars and lenses of mafic minerals, but augmented by foliation-parallel, pyroxene-bearing pegmatitic rocks. An additional feature observed by the author is the rare presence of fine-grained, lensy-banded, migmatitized tonalitic rocks that were compared in field notes (CG79-375) to possible felsic volcanic remnants seen on Webeck Island in the Cape Harrison domain, and noted as possibly related to the Aillik Group. Similar rocks were recorded at CG79-349 and garnet-bearing calcic pods were noted at CG79-363. Associated with the rocks are mafic enclaves of various sorts, which could be disrupted equivalents of the multiple generations of post-gneissosity mafic dykes that are also prevalent. Minor granitoid intrusions both predate and postdate mafic dyke injection.

A key aspect of Owen's (1985) study was recognition of granulite-facies assemblages in the WBIGC. Two-pyroxene-bearing assemblages were found in both dioritic–tonalitic gneiss and jotunitic–charnockitic gneiss, and in some pre-migmatitic metabasites. Biotite is a co-existing mafic mineral, but hornblende is retrogressive. Mineral analysis show that the orthopyroxene is, most typically, ferrohypersthene (Mg/Mg+Fe = 0.33 to 0.61), and is closely related to bulk-rock composition. Garnet was only found in two jotunitic–charnockitic gneiss samples, seemingly in equilibrium with orthopyroxene. Owen *et al.* (1988) summarized findings from application of various geothermometers and geobarometers and concluded (conservatively) that temperatures were between 650° and 750°C and minimum pressures were somewhere in the range of 4 to 6 kb. They cautioned that quantitative estimates were hampered by potential mineral composition modification during subsequent metamorphic retrogression. Note that granulite-facies mineral assemblages were not found in the CHMS correlatives a few kilometres to the north, implying exhumation of deeper level crust south of the Cutthroat Island thrust during Grenvillian or earlier tectonism.

The author's thin section collection includes eight samples from sites within the WBIGC (CG79-339, CG79-344, CG79-366, CG79-369, CG79-377.1, CG79-377.2, CG79-383, CG92-065A). They add little to Owen's investigation. They include dioritic, monzodioritic, granodioritic and granitic gneiss, but all lack either pyroxene or garnet, instead mostly show amphibolite facies assemblages. Note that the collection includes U–Pb and Sm–Nd sample CG92-065A, which contains plagioclase, microcline, quartz, olive-green biotite, epidote and accessory allanite, opaque oxides, titanite and zircon.

## 6.4 LATE- TO POST-MAKKOVIKIAN GRANITOID ROCKS (1800–1790 Ma)

Granitoid rocks interpreted to be late- to post-Makkovikian in the Cape Harrison domain can be conveniently divided between those in the west and those in the east. They are separated by the Cape Harrison Metamorphic Suite and Labradorian intrusions. The western group of granitoid rocks is much better known (including U–Pb ages).

### 6.4.1 WESTERN CAPE HARRISON DOMAIN

In the west, there are three separately defined units, namely: i) the Big River granitoid rocks, ii) the Stag Bay granodiorite, and iii) the Numok Intrusive Suite. Granitoid rocks on Double Island and Little Double Island are included with these (Figure 6.4; Appendix 2, Slab images 6.3).

Representative samples from all three suites have been dated by U–Pb methods and yield analytically identical 1802–1800 Ma ages. The Big River granite has an age of 1802 ± 2 Ma based on two multigrain zircon fractions, one concordant and one near concordant (Kerr *et al.*, 1992; K-feldspar megacrystic biotite hornblende granite, sample AKZ-23). A seven-point, whole-rock, Rb–Sr isochron by Kerr (1989a) for the Big River granite yielded an analytically identical age of 1798 ± 28 Ma ($I_{Sr}$ = 0.70173).

The Stag Bay granodiorite has an age of *ca.* 1800 Ma based on one fraction of near-concordant zircon. It has a minimum age of 1799 Ma ($^{207}$Pb/$^{207}$Pb) and maximum age of 1825 Ma, if the regression is anchored at 1000 Ma (Kerr *et al.*, 1992; seriate to porphyritic biotite granodiorite to monzogranite, sample AKZ-6). If the Pb loss was earlier (*e.g.*, Labradorian), then, of course, the maximum age would be greater (*cf.* Deus Cape megacrystic granitoid rock). Kerr (1989a) earlier obtained a five-point, whole-rock, Rb–Sr isochron of 1714 ± 44 Ma ($I_{Sr}$ = 0.70352) for the same unit, which might reflect disturbance resulting from the subsequent emplacement of the nearby Dog Islands granite.

The age of the Numok Intrusive Suite is based on two samples. One sample, a fayalite–clinopyroxene-bearing syenite (AKZ-5), gave a concordant result of 1801 ± 2 Ma based on one zircon fraction. Two zircon fractions from the other sample, a quartz monzonite (HSZ-1), gave a combined regression of 1802 +8/–2 Ma. The 1801 Ma result was adopted as dating emplacement (Kerr *et al.*, 1992).

#### 6.4.1.1 Big River Granitoid Rocks ($P_{2C}$gr, $P_{2C}$ga)

Except on the coast (*cf.* Kranck, 1953), the Big River granitoid unit was first mapped by Stevenson (1970; part of his units 6 and 7), and subsequently by Gower (1981; part of his Unit 23) and Gower *et al.* (1982a, their Unit 26b). The name Big River granite was introduced by Kerr (1989a, 1994).

The rocks are pink, buff, or white-weathering, typically coarse grained, and even textured. They are dominantly granite to alkali-feldspar granite, but include some quartz monzonite and quartz syenite (Plate 6.5A). Some medium-grained, sugary textured granite is present locally. The rocks range from massive to strongly foliated and have sporadic epidote-filled fractures. Fabrics tend to be best developed in the south and are most readily attributed to Grenvillian deformation, but this is not a complete explanation because some fabrics have a north to northeast trend (*e.g.*, SGJ68-116) and are, therefore, more likely related to Makkovikian deformation. The rocks commonly have a seriate to K-feldspar megacrystic appearance, as shown by euhedral, sparse to abundant megacrysts up to 5 cm long (partly augenform in the south). Kerr (1989a) emphasizes a mantled-feldspar character (which he termed pseudo-rapakivi), displayed by plagioclase crystals mantled by K-feldspar. Blue quartz is present locally. The granite also carries sparse mafic and felsic enclaves and is intruded by mafic dykes and a few aplitic and pegmatitic veins. Age relationships with other units in the region are poorly known, mostly because contacts are faulted. Kerr (1989a) mentioned a grey dioritic granitoid rock in the eastern part of the unit, which he suggested might represent a screen of older material. In field notes, Stevenson's assistant noted granite intruded into dioritic gneiss (N68-169), which may be the same thing.

As the Big River granite is essentially a 'fringe' unit in the author's mapping, it is only represented by a relatively small collection of thin sections, most of which were inherited from other projects (AL78-168, AL78-186, AL78-200B, AL78-206, AL78-225, AL78-232, AL78-235, CG79-425, CG79-687, CG82-002, CG83-627, N68-126, SG68-310). These are adequate, however, to demonstrate that the unit includes several different rock types and further investigation is needed to understand their relationships. The most characteristic rock type (AL78-168, AL78-186, AL78-232, AL78-235, N68-126) is granite to alkali-feldspar granite in which plagioclase is very much a subsidiary phase and occurs as strongly zoned, relict grains enveloped, or associated with, pethitic K-feldspar (partially inverted to microcline). It is these plagioclase cores that give rise to the pseudo-rapakivi texture to which Kerr (1989a, 1994) makes reference. The same rocks also feature relict dark blue-green (sodic) amphibole that is partially pseudomorphed by olive-green biotite, an opaque oxide (typically mantled by titanite), and quartz. Apatite, zircon, allanite (commonly forming large, euhedral crystals, locally displaying multiple growth stages; *e.g.*, N68-126), and secondary epidote and white mica are also present. The zoned, relict plagioclase and changing mafic-mineral assemblage point to disequilibrium in an evolving magma.

Four samples from the southern part of the unit (CG82-002, AL78-200B, AL78-206, AL78-225) are strongly deformed, extensively recrystallized and heterogeneously textured. The fabric can be most obviously attributed to Grenvillian deformation, but the possibility that these rocks represent some other unit should not be dismissed.

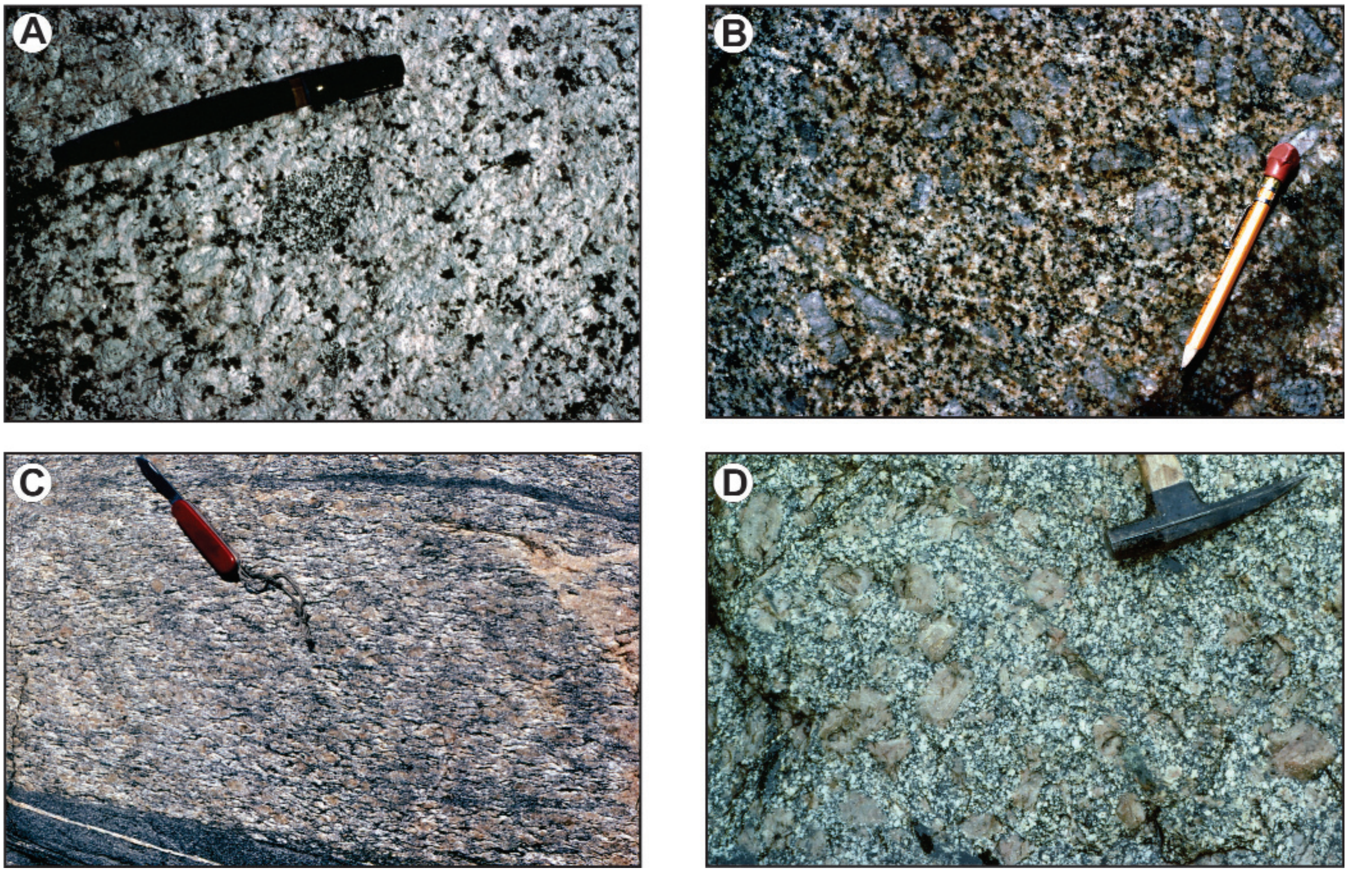


**Plate 6.5.** *Examples of late- to post-Makkovikian granitoid rocks in the Cape Harrison domain. A. Big River granitoid rock (AL78-190), B. Stag Bay megacrystic granodiorite (AL78-153), C. Numok Intrusive Suite (AD79-129), D. Byron Bay megacrystic granitoid rock (CG79-177).*

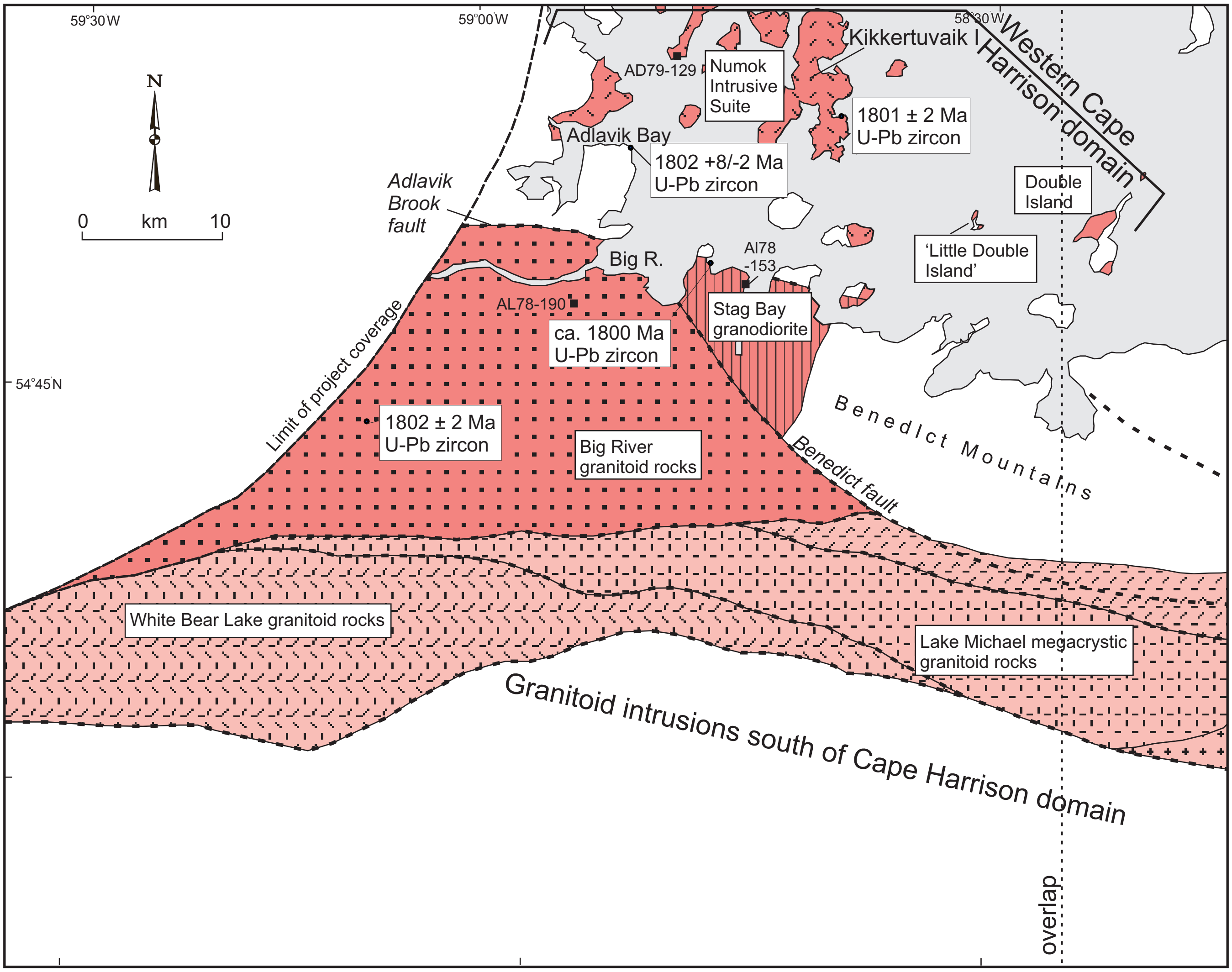


**Figure 6.4.** *Subdivision of late- to post-Makkovikian granitoid rocks in the Cape Harrison domain, and potentially correlative rocks to the south.*

Two petrographic oddities were found in the southeast area. The first (CG79-425) has relict aegerine–augite and a deep purplish-blue amphibole that is either riebeckite, or a close relative. It also has K-feldspar porphyroclasts in a comminuted, highly recrystallized groundmass. Given its location, it might be unrelated to the Big River granite. The second is a texturally distinct sample (CG79-678), from 3 km to the southeast. It lacks amphibole but has clusters of biotite, epidote and titanite that may represent pseudomorphs of it.

A sample that is unique to the area (SG68-310) is a deformed, heterogeneously textured, fine- to medium-grained, recrystallized quartzofeldspathic granulite, containing relict, moderately pleochroic orthopyroxene. This is intriguing, as granulite facies rocks are otherwise unknown in the Cape Harrison domain of the Makkovik Province. There is no reason to suspect data-station location error or sample mix-up, so a likely explanation is that it is a xenolithic raft of older rock.

#### 6.4.1.2 Stag Bay Granodiorite (P$_{2C}$gp)

The Stag Bay granodiorite was not identified as a separate unit by Kranck (1953) or Stevenson (1970), but was distinguished by Gower (1981; part of his Unit 19). In Makkovikian *vs.* Labradorian terms, it was left as 'unclassified Stag Bay granitoid' by Kerr (1989a), but, following U–Pb dating (Kerr *et al.*, 1992, *see* earlier), it was reassigned as posttectonic Makkovikian and the name modified to Stag Bay granodiorite by Kerr (1994).

The rock is characterized by pink, euhedral K-feldspar megacrysts (up to 2 cm long) in a white, plagioclase-dominated, medium- to coarse-grained matrix (Plate 6.5B). Because of the plagioclase-rich matrix, the overall composi-

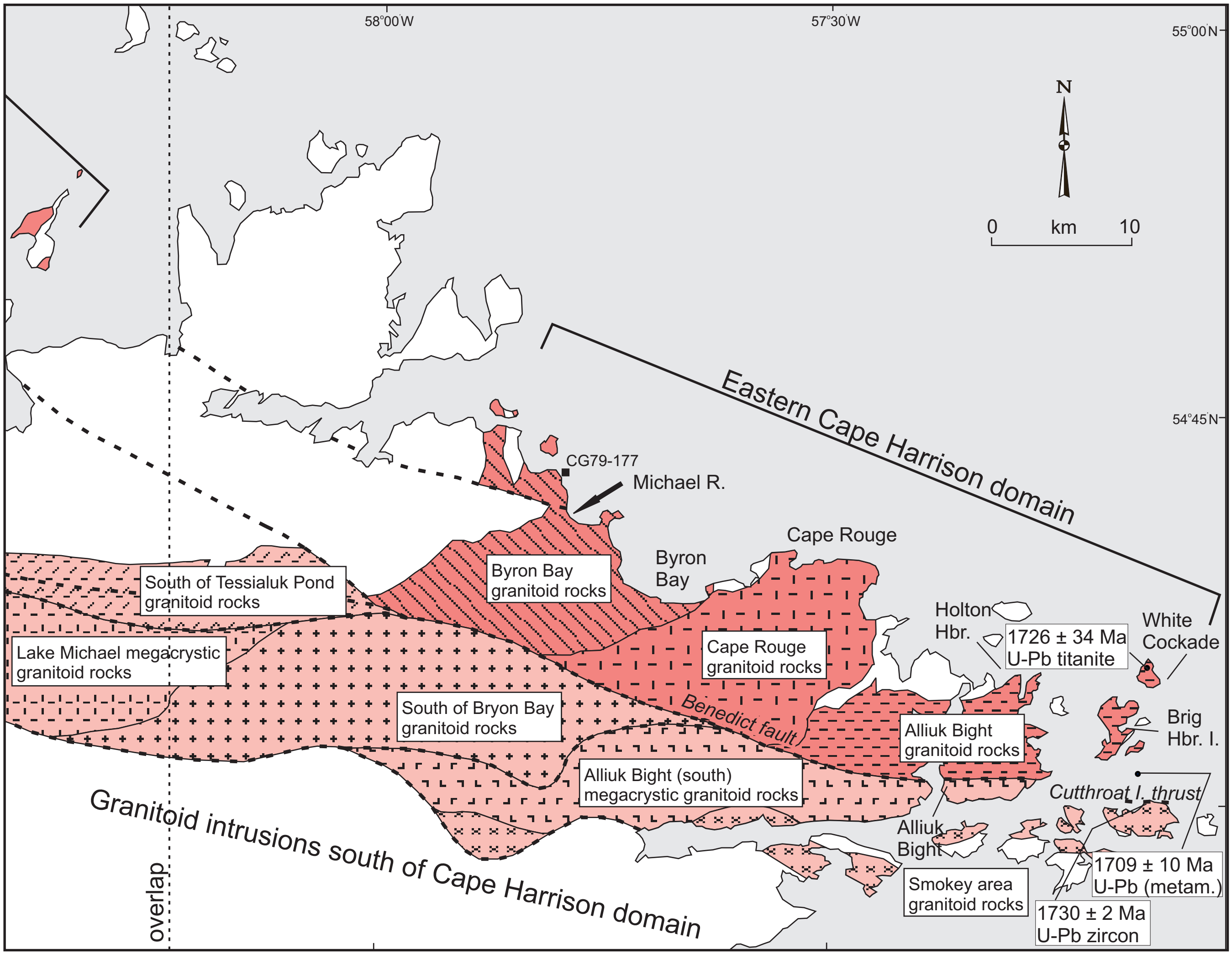


**Figure 6.4.** *Continued.*

tion is a biotite granodiorite, but it probably grades into quartz monzonite in places. The K-feldspar megacrysts are zoned, and have inclusions of plagioclase and biotite. The rock is mostly massive to weakly foliated. The fabric may be partly attributed to deformation along the Benedict fault, which defines its southwestern boundary, but a north-trending fabric seen in coastal outcrops is more likely related to Makkovikian orogenesis. Epidote-filled fractures occur sporadically. Rare elliptical mafic to intermediate enclaves, up to about 25 cm long, are present. Stevenson, in field notes (SG68-162), recorded numerous angular felsic enclaves that he suggested to be of Aillik Group origin. The granitoid rocks are intruded by southeast-trending plagioclase-phyric and non-phyric mafic dykes, ranging from 1 to 100 m wide. Rare aplite is also present and pegmatitic material was noted to intrude mafic dykes at SG68-164. Kerr (1989a) records that the Stag Bay granitoid unit is intruded by a feldspar-porphyry dyke, which he considered might be related to the Dog Island granite.

Four thin sections are available (AL78-153, CG79-025, CG79-028, SG68-163). Samples CG79-025 and Al78-153 are very similar. Plagioclase is subhedral to euhedral, strongly zoned and has broad albitic margins. It has a cumulate aspect, having quartz occupying much of the space between plagioclase crystals. K-feldspar also contains plagioclase. Mafic minerals consist of clusters of secondary olive-green biotite, chlorite, epidote, titanite, and opaque oxides that have replaced amphibole (partly preserved as blue-green relicts). Accessory phases include an opaque oxide, apatite and zircon. In CG79-028, some plagioclase is zoned, but it is less obviously early than in the other samples and more likely to have crystallized eutectically with quartz and K-feldspar. It also has primary biotite and hornblende. Sample SG68-163 is recrystallized and very much finer grained, but it has some similar petrographic features to its coarse-grained counterparts (*e.g.*, zoned plagioclase, partially pseudomorphed amphibole). It could be a cognate enclave or, as interpreted by Stevenson, a xenolith correlative with the Aillik Group.

### 6.4.1.3 Numok Intrusive Suite ($P_{2C}$mz, $P_{2C}$mq, $P_{2C}$gr, $P_{2C}$yq)

The Numok Intrusive Suite was named by Kerr (1989a, 1994), for an area of monzonite, quartz monzonite, syenite and quartz syenite that underlies a group of islands north of the Benedict Mountains, and the adjacent mainland in the Adlavik Bay area (Plate 6.5C). This area is correlated with a second body of similar rocks west of Big River. The two areas are offset from each other by *ca.* 20 km across the Adlavik Brook fault (Figure 5.3).

The rocks were earlier recognized as distinct, at least in part, by Kranck (1953) and Stevenson (1970). Kranck grouped them as part of (what is now termed) the Strawberry Intrusive Suite, whereas Stevenson separately distinguished some of them as a group of syenite, monzonite and syenodiorite bodies that he thought could be related to the Adlavik Intrusive Suite. Further mapping of the northern area was carried out by Bailey *et al.* (1979; peripheral only) and Doherty (1980). Doherty concurred with Stevenson's division on Kikkertavak Island[1] between granite in the west and syenite in the east, but showed the rest of the area as syenite, whereas Stevenson termed it granite. Doherty also noted that some of the rocks in the northern part of his mapped area closely resemble the Cape Strawberry granite. Doherty's mapping was compiled without significant modification by Gower (1981; his units 15 and 24) and Gower *et al.* (1982a; their units 23 and 31) at 1:100 000-scale as part of the (now obsolete) Benedict Mountains Intrusive Suite. In the next studies, Kerr (1986, 1987) also grouped the rocks with the Adlavik Intrusive Suite, but this correlation was later rejected by Kerr (1994) after two samples from the Numok Intrusive Suite yielded 1800 Ma dates in contrast to 1649 Ma for the Adlavik Intrusive Suite (Kerr *et al.*, 1992). The dates also, of course, denied correlation with the Strawberry Intrusive Suite. The confusion stems from mapping complex rocks at only at reconnaissance level, coupled with lack of adequate supporting laboratory studies. Although Kerr's assessment of the rocks remains the best available, further mapping refinements and nomenclature revisions seem likely.

Only the Numok Intrusive Suite in the area of islands north of the Benedict Mountains is addressed here, as the second area south of the Adlavik Brook fault is outside the scope of this report. In the 'islands' area, the summary relies on field descriptions, rock samples (including stained slabs) and thin sections from the mapping of Stevenson (1970), Bailey *et al.* (1979; specifically, assistant A. Lalonde), and Doherty (1980). Based on Gower's (1981) compilation, the rocks are divided here into two, probably intergradational, main groups, namely: i) monzonite, quartz monzonite, and lesser syenite, and ii) syenite, quartz syenite and alkali-feldspar syenite. For the 'islands' area, Kerr (1989a, 1994) also adopted this division and largely accepted its previously mapped rock-type distribution, but added an additional monzodiorite unit for the inland area south of the Adlavik Brook fault.

*Monzonite, quartz monzonite, and lesser syenite.* The unit comprises white, creamy, grey or pink-weathering, coarse-grained, massive to foliated, biotite hornblende monzonite and quartz monzonite, and minor brown-weathering syenite to quartz syenite. K-feldspar megacrysts, up to 3 cm long, are present sporadically. Megacrystic granite was noted to be chilled against non-megacrystic granite. Although not typically quartz rich, some larger-than-normal quartz crystals (quartz eyes) were noted in several places. Mantled feldspars and graphic-granite textures were also recorded. The unit may be homogeneous or heterogeneous, the latter due to numerous enclaves, or later agmatically injected material. Enclave material includes: i) fine- to medium-grained quartzofeldspathic material (gossanous in part) probably derived from the Aillik Group, ii) migmatitic dioritic, granodioritic and granitic material, and iii) mafic and ultramafic pods, showing a variety of spotted, layered and brecciated aspects. The rock is intruded by various K-feldspar porphyry and non-porphyry granitic dykes, as well as diabase and lamprophyric dykes. Kerr (1994) compared the porphyry dykes with the Dog Island granite.

Kerr (1989a, 1994) describes the western border of the intrusion as a complex agmatite, up to 1 km wide, comprising grey-brown quartz monzonite hosting numerous undeformed blocks of diabase, gabbro, leucogabbro and porphyritic diorite, around which a flow fabric is developed. Reasonably enough, this agmatite has been interpreted (Gower, 1981; Gower *et al.*, 1982a; Kerr, 1986) as indicating emplacement of quartz monzonite into Adlavik Intrusive Suite, but Kerr *et al.*'s (1992) finding that the neosome in this agmatite crystallized at 1801 ± 2 Ma seems to invalidate such an interpretation, at the same time implying an earlier suite of mafic rocks.

Thin sections of the monzonite to quartz monzonite (AD79-095, AD79-100, AD79-109, AD79-121, AD79-126, AD79-157, AL78-027, AL78-077, N68-103) form a fairly coherent group. The rocks are characterized by large sodic plagioclase grains having broad albitic rims; patchy perthitic K-feldspar, partially inverted to microcline and containing plagioclase inclusions; quartz partly interstitial between larger feldspar grains, but locally abundant enough to term the rock granite (*e.g.*, AL78-077); dark blue-green (sodic) amphibole, locally altered to dark orange-brown biotite; orange-brown and olive-green biotite; and accessory opaque oxide, apatite, zircon, titanite (mantling opaque oxide), and chlorite. Relict clinopyroxene, largely replaced by amphibole and quartz, is present in AL78-027. One sample (AD79-100) is igneous-textured, K-feldspar-quartz porphyry, also having clusters of olive-green biotite, titanite, opaque oxides (mantled by

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[1] Note that this is not the same Kikkertavak Island as that giving its name to the Kikkertavak mafic dykes.

titanite) associated with relict blue-green amphibole which was probably the original primary igneous mafic silicate. The matrix is fine grained and recrystallized. Four samples are most readily interpreted as enclaves of Aillik Group felsic volcanic/volcaniclastic rocks (AD79-067, AD79-077, AD79-109, AD79-142). Sample AD79-067 is crystal tuff characterized by phenoclasts of strongly zoned, euhedral primary igneous plagioclase 1–3 mm wide and having strongly altered cores and broad K-feldspar rims (perthitic, but partially inverted to microcline). K-feldspar forms 1–2-mm-wide independent primary igneous grains. In contrast, sample AD79-077 lacks phenoclasts and is extensively recrystallized, but retains evidence of grain-size stratification. Sample AD79-142 falls between these two types in that it contains larger-than-groundmass K-feldspar and quartz grains, set in a fine-grained, grain-size-stratified matrix. The large felsic grains have irregular recrystallized margins, but retain vestiges of their primary nature. In all three samples, the fine-grained matrix consists of quartz, chlorite, altered olive-green biotite and distinctly pleochroic epidote, ± titanite, ± allanite, ± opaque minerals (oxide and sulphide). At data station AD79-067, the rock was described in the field as a granodioritic pod. The petrographic evidence makes clear that this is not correct, thereby rendering other fine-grained granodiorite field identifications suspect. Sample AD79-109 is slightly different in that it is a bit coarser grained and lacks stratification. It may be a sub-volcanic intrusive rock.

*Syenite, quartz syenite and alkali-feldspar syenite.* The rocks are pink, brown or grey-green, coarse to very coarse grained, massive to moderately foliated, locally K-feldspar megacrystic, pyroxene biotite hornblende syenite, quartz syenite and alkali-feldspar syenite (and rare syenodiorite). The rocks are typically quartz- (blue-grey in part) poor. Locally, the rocks show compositional banding (AD79-027) and have fine-grained aplitic segregations. Gabbroic and pyroxenitic enclaves are present and the unit is intruded by diabase dykes. As noted by Kerr (1994), the syenitic rocks are commonly very weathered (being reduced to ocherous gravel in outcrop), in consequence of their Fe-rich composition.

Four thin sections (AD79-027A, AD79-075, AD79-172, N68-104) of syenitic rock were examined. The rocks are dominated by patch perthite. Plagioclase is subsidiary or absent and is typically albitic. Quartz is interstitial or absent. Pale-green clinopyroxene with exsolved Fe-oxide is present in all samples. It is typically fringed by blue-green (sodic) amphibole–quartz symplectite, but a colourless polysynthetically twinned amphibole (cummingtonite?) is also present. Biotite–quartz symplectite associated with titanite and opaque oxides (and locally, carbonate and epidote) is also present and all are interpreted as breakdown products of Fe-rich clinopyroxene. Other accessory minerals are apatite and zircon. Fayalite is not present in the above-listed samples but was reported by Kerr (1989a, 1994), who describes it as extensively altered to iron oxide–hydroxide. One other sample from the area of syenitic rocks was examined in thin section (AD79-174). It is an ultramafic rock, consisting of cumulus pale-green clinopyroxene (displaying exsolved Fe-rich lamellae) with intercumulus opaque oxide, apatite and titanite. Green-brown amphibole and orange-brown biotite appear to be partly intercumulus and partly secondary. A field photograph suggests that it is a large enclave, rather than a dyke.

#### 6.4.1.4 ‘Little Double Island’ Granitoid Rocks ($P_{2C}$gd)

The rocks on ‘Little Double Island’ were neglected during the mapping of Kranck (1953) and Stevenson (1970), but were examined by Gower (1981), who indicated a 0.5-km-wide, northeast-trending central septum of fine-grained quartzofeldspathic gneiss (considered to be an Aillik Group correlative) flanked by strips of granitoid rocks on either side. The granitoid rock on the northwest side is pink, medium-grained, biotite granite to granodiorite containing mafic mineral concentrations that suggest igneous crossbedding, and intruded by net-veined mafic dykes, pegmatite and microgranite. The rock on the southeast side is a medium- to coarse-grained, sporadically K-feldspar megacrystic biotite granite to granodiorite with enclaves of well-banded gneiss and intruded by mafic dykes. None of the rocks received post-field investigation. Relationships to other granitoid bodies in the region are not known, but (pre-Adlavik Brook fault) correlation with the Big River granitoid rocks seems most plausible to the author.

#### 6.4.1.5 Double Island Granitoid Rocks ($P_{2C}$gr, $P_{2C}$gp, $P_{2C}$gd)

The only certainty with respect to the bedrock of the Double Islands is that both Aillik Group-correlated supracrustal rocks and granitoid intrusions are present. Their depicted distribution differs on all maps that show them (Christie *et al.*, 1953; Kranck, 1953; Stevenson, 1970; Gower, 1981; Kerr, 1994; Gower, 2010a; Benedict Mountains map region).

Gower’s (1981) representation was modified by Gower (2010a) to accommodate field observations made by Davidson and Kowalczyk (1979) during mineral exploration in the region. Both of Gower’s maps, in essence, show a central northeast-trending zone of supracrustal rocks, flanked, to the northwest, by K-feldspar megacrystic biotite granite that is similar to the Stag Bay granitoid unit and, to the southeast, by massive granite that resembles the Tukialik granite.

Only the megacrystic granitoid rock on the northwest side was examined petrographically (CG79-071). Plagioclase is strongly zoned and has albitic margins, but lacks the euhedral, ‘cumulate’ aspect present in the Stag Bay granitoid with which it is possibly correlative (but it is also much more recrystallized). In outcrop, K-feldspar megacrysts are up to 6 by 3 cm. A megacryst seen in thin section is mostly flame perthite, but partially inverted to microcline and is host to numerous zoned plagioclase inclusions. Mafic minerals consist of clusters of secondary olive-green biotite, chlorite, epidote, titanite, and opaque oxides that have replaced amphibole (partly preserved as blue-green relicts). Accessory phases include an opaque oxide, apatite and zircon. Several of these features are also present in the potentially correlative Stag Bay granitoid unit.

### 6.4.2 EASTERN CAPE HARRISON DOMAIN

In the east, three separate granitoid groups have been defined, namely: i) the Byron Bay granitoid rocks, ii) the

Cape Rouge granitoid rocks, and iii) the Alliuk (Abliuk on some maps) Bight granitoid rocks. All the names are newly introduced here. None of the three units defined here were distinguished separately from other granitoid units in the region on the maps of Christie *et al.* (1953), Kranck (1953) or Stevenson (1970), being first mapped by Gower (1981, parts of his units 19, 20, 23 and 28). None of these rocks were included in the study of Kerr (1989a, 1994). Coastal outcrops of the Cape Rouge and Alliuk Bight granitoid rocks were examined by Owen (1985; his units 6A, B, D and E).

Unlike the suites in the west, these do not have distinctive separate identities, they are less well dated, and they are distinguished from each other simply by their geographic distribution. All may belong to a single magmatic event. In the absence of U–Pb geochronological data (except one titanite result – *see* below), assigning these rocks as late Makkovikian utilizes morphology-based evidence and Rb–Sr dates.

Morphology-based evidence relies on field records identifying northeast-oriented foliations and enclaves (Makkovikian trend), plus petrographic observation that felsic minerals (especially quartz) are generally only mildly recrystallized (*viz.* postdating most Makkovikian deformation).

Rb–Sr geochronological data were obtained by Owen (1985) and Owen *et al.* (1988). All the rocks addressed in this section belong to Owen's Unit 6, which he divided into five subunits, 6A – monzodiorite to granodiorite, 6B – monzodiorite, 6C – leucogranite–granite, 6D – megacrystic granite, and 6E – monzonite–granite. From field relationships, Unit 6B is older than Unit 6C and Unit 6D is older than Unit 6E. Unit 6A was interpreted to be the oldest because it has the most pervasively developed Makkovik-trend fabrics.

Unit 6A gave a whole-rock seven-point Rb–Sr regression date of 1787 ± 35 Ma, $I_{Sr}$ = 0.70233. For the author, the issue with this unit is that five of the seven samples come from localities south of the Cutthroat Island thrust, and that the two from north of the thrust have much higher Rb/Sr and $^{87}Sr/^{86}Sr$ values than four of the five samples south of the thrust, which brings into question the validity of combining all the samples in a single regression.

Unit 6B gave a whole-rock nine-point regression of 1697 ± 41 Ma, $I_{Sr}$ = 0.7040. This unit has an analogous issue in that six of the nine samples come from localities south of the Cutthroat Island thrust, and that two of the three samples from north of the thrust have much lower Rb/Sr and $^{87}Sr/^{86}Sr$ values than five of the six samples from south of the thrust.

Unit 6E gave a whole-rock four-point regression of 1725 ± 31 Ma, $I_{Sr}$ = 0.7032. All four localities are from north of the Cutthroat Island thrust.

The U–Pb titanite age alluded to above is 1726 ± 34 Ma and was interpreted to date metamorphism (Krogh *et al.*, 2002; sample V333 from White Cockade Island), noting that it is nominally coeval with a 1730 ± 2 Ma zircon age from a pegmatite that postdates most of the mylonitic deformation in the Cutthroat Island thrust.

Overall, although Owen's correlations across the Cutthroat Island thrust may well be valid, the contrasting Rb/Sr and $^{87}Sr/^{86}Sr$ characteristics on either side call for caution in their use. Coupled with the field evidence and the titanite date, a best-estimate time of emplacement of his Unit 6 is between 1800 and 1730 Ma.

### 6.4.2.1 Byron Bay Granitoid Rocks ($P_{2C}$gp, $P_{2C}$gr, $P_{2C}$ga)

*Megacrystic granitoid rocks.* The rock type forms all the shoreline between the mouth of Michael River and Cape Rouge, and the same rock was traced inland for about 10 km, inferred to terminate against the Benedict fault. It is pink and grey, coarse-grained, massive, even textured, seriate to K-feldspar megacrystic granodiorite to quartz monzonite. Its identity is best defined by particularly large K-feldspar megacrysts, commonly 5 to 7 cm long and nearly as wide (Plate 6.5D). They are euhedral, zoned and show obvious simple twinning. The groundmass is also fairly coarse grained, in which strongly saussuritized plagioclase, weakly recrystallized quartz, biotite, hornblende (up to 0.7 cm), titanite and opaque minerals can all be easily recognized in hand sample (CG79-545). Fabric is weak or lacking, except for one example of brittle, non-penetrative shearing (CG79-259). The rock contains a few northeast-aligned, amphibolite enclaves and very rare minor granitoid veins (except at site SG68-092, where many aplites were recorded). Two rock type departures from the above description are: i) non-megacrystic, massive, coarse-grained granite at CG79-544 and CG79-546, similar to the Bryon Bay non-megacrystic granite reviewed in the next section, and ii) an anomalous rock at SG68-211 described by Stevenson (field notes) as a mixture of granitic gneiss and a grey, quartzitic rock rich in pyrite (possibly Aillik Group supracrustal rocks? – author). Sample CG79-545 has given Sm–Nd values of $T_{DM}$ 2007 Ma and εNd = +1.07.

Sample CG79-545 was examined in thin section. Plagioclase is strongly zoned, displaying saussuritized cores. K-feldspar is microcline and contains abundant inclusions (megacrysts = porphyroblasts?), quartz is unrecrystallized or only slightly so. Blue-green amphibole is a major mafic phase and is partially pseudomorphed to olive-green biotite, epidote, chlorite, titanite and opaque oxides. Other accessory minerals are allanite (up to 1 cm long) and zircon.

*Non-megacrystic granitoid rocks.* Rocks included here as Byron Bay granite underlie a triangular area between Michael River, the Byron Bay megacrystic granitoid rock and the Benedict fault. In contrast to the coherent Byron Bay megacrystic unit, these rocks include texturally variable rocks that are unlikely to represent a single intrusion. The rocks are mainly medium- to coarse-grained, massive to foliated, biotite hornblende granite, alkali-feldspar granite and quartz monzonite. Some large bodies of coarse-grained gabbroic rocks are associated (assumed to be Adlavik Intrusive Suite correlatives), and the rocks are locally intruded by abundant pegmatite and a few mafic dykes.

Two thin sections from this area typify the diversity of rock types, inasmuch as one is biotite-bearing alkali-feldspar granite (CG79-543) and the other is a strongly recrystallized, texturally heterogeneous, fine-grained, quartzofeldspathic rock that might well have been derived from a volcanic protolith (SG68-089A).

### 6.4.2.2 Cape Rouge Granitoid Rocks ($P_{2C}$gp, $P_{2C}$ga)

*Megacrystic granitoid rocks.* The rock type forms all the shoreline between the Bryon Bay megacrystic granitoid unit and the Holton Harbour syenite (*see* Figure 6.5) and the same rock type was mapped at some locations inland. The description following is very similar to that for the Bryon Bay megacrystic unit and they may both belong to a single unit.

The Cape Rouge megacrystic granitoid is a pink- and grey-weathering, coarse-grained, K-feldspar megacrystic rock that has a composition straddling the granite, granodiorite and quartz monzonite fields. It is generally massive or weakly foliated, except in some southern locations, where the fabric may be the product of Grenvillian deformation. The K-feldspar megacrysts are typically 3 by 2 cm, but reach up to 6 by 4 cm. They are euhedral, simple twinned, and sparse to abundant (up to 50% of the rock). Mafic enclaves, typically less than 20 by 5 cm but up to 1 m, are fairly common. Enclaves have a north to northeast (Makkovikian) trend and locally contain K-feldspar megacrysts (porphyroblasts) identical to those in their host rock. The rocks are intruded by deformed and undeformed mafic dykes, and rare pegmatite and microgranite veinlets. The contact with the Holton Harbour syenite is agmatitic and gradational and is also marked by abundant remnants of probable supracrustal rocks, some of which are rather siliceous. Rafts of K-feldspar megacrystic granitoid rocks occur within the Holton Harbour syenite.

Five thin sections of the Cape Rouge megacrystic granitoid unit are all fairly similar (CG79-269, CG79-273, CG79-279A, CG79-290, CG79-571). Felsic minerals are largely igneous, but show patchy areas of recrystallization. Plagioclase commonly shows marked zoning, including oscillatory zoning. K-feldspar is a mixture of perthite and microcline. Quartz is only slightly recrystallized. Biotite is green-buff to buff-orange and, along with titanite and an opaque mineral, is a product of the breakdown of hornblende, now retained as blue-green relicts. Accessory minerals include an opaque oxide (sulphide in CG79-279, CG79-571), apatite, titanite (partially mantling the opaque mineral), zircon and allanite. Secondary white mica, chlorite and epidote are sporadically present.

*Non-megacrystic granitoid rocks.* Rocks referred to here as Cape Rouge granite are associated with the Cape Rouge megacrystic granitoid unit in a ‘blobby’ sort of map pattern, south and southwest of Cape Rouge. The rocks are pink- or buff-weathering, coarse-grained and massive to strongly foliated granite, alkali-feldspar granite, and quartz monzonite/syenite. Large quartz crystals are a feature (up to 0.8 cm across in undeformed rocks and 2 by 0.3 cm lenticular grains in deformed equivalents). Minor, fine-grained granodioritic material was also seen (xenolithic rafts?). Horizontal mafic dykes were recorded on two offshore islands (Tinker Island and Quaker Hat Island – *see* 1:100 000-scale maps for locations). From Quaker Hat Island, Grasty *et al.* (1969) obtained a K–Ar whole-rock age of 1479 ± 18 Ma (recalculated) from a hornblende biotite lamprophyre dyke. Pegmatite was recorded at one site. The rocks are similar to some of the Byron Bay granite unit, and, like their K-feldspar megacrystic partners, may correlate.

One point that requires discussion concerns the location and relevance of a K–Ar biotite age of 1432 ± 50 Ma (recalculated) for a massive to slightly foliated granite from the ‘southeast shore of Bryon Bay’ (Wanless *et al.*, 1972; sample GSC7-138). Initially, one might think that it was a sample of Byron Bay megacrystic granitoid rock (*see* earlier) that was investigated, as that is the rock type on the shoreline, but such may not be the case. The sample was collected by Stevenson from his site SG68-094, which his data-station map shows to be located about 700 m inland to the east, which puts it in the Cape Rouge granite according to Gower (2010a; Byron Bay map region). On the other hand, Stevenson recorded a 10-m-wide, 110°-trending diabase dyke at his locality, and Gower recorded a ‘large’ mafic dyke (width and trend unspecified) at his shoreline data station 600 m to the west-southwest, leaving the author with niggling doubts regarding what was sampled and where it came from.

Five thin sections are available (CG79-567, CG79-572, CG79-576, CG79-578, SG68-094). The mineral assemblage is similar to that in the Cape Rouge megacrystic granitoid unit, but with some differences. This group of rocks is: i) more leucocratic, ii) only two of the five thin sections have minor relict amphibole, and iii) three have minor fluorite and lack epidote (CG79-567, CG79-576, SG68-094). Such differences are consistent with more advanced fractionation. Note that the thin sections include one for the 1432 Ma dated sample SG68-094. Of the five samples, it has the highest mafic mineral, making it more characteristic of the Byron Bay/Cape Rouge megacrystic rocks. On the other hand, it also contains fluorite, which seems to be restricted to the Cape Rouge non-megacrystic granite.

#### 6.4.2.3 Alliuk Bight Granitoid Rocks ($P_{2C}$gp, $P_{2C}$gr, P2Cmz)

*Megacrystic granitoid rocks (including monzonitic types).* The rock type forms all the shoreline exposures east and south of the Holton Harbour syenite, except for that occupied by the Brig Harbour Island mafic intrusion (which is exposed on many islands between Brig Harbour Island and the mainland to the west). A U–Pb titanite age of 1726 ± 34 Ma was interpreted to date metamorphism (Krogh *et al.*, 2002; sample V333).

The rocks are pink- or grey-weathering, medium- or coarse-grained, granite, quartz monzonite and monzonite. They are variably foliated, displaying foliations best developed in the east and south. The rocks have a seriate to megacrystic aspect, having K-feldspar megacrysts typically 2 by 1 cm, but up to 5 by 2 cm. The megacrysts are sparse to abundant, euhedral to anhedral, may be zoned, and tend to be oriented according to the prevailing foliation. This description differs somewhat from that of Owen (1985) for his Unit 6B, which he shows as the unit underlying much of the same area. He terms the rock monzodiorite to monzonite and does not mention it as being K-feldspar megacrystic. Enclaves are common in some parts of the unit and are both mafic (amphibolite, gabbro, and diorite) and felsic (granite and syenite). Field notes indicate that enclaves are most abundant in the northwest part of the unit. The granitoid rocks are intruded by both net-veined and planar mafic dykes, which show some boudinage. Minor granitoid intrusions both predate and postdate mafic dyke emplacement.

Nine thin sections of the Alliuk Bight megacrystic unit are all fairly similar, but with a few exceptions (CG79-295A, CG79-295B, CG79-300, CG79-308, CG79-311, CG79-316, CG79-613, CG79-614, SG68-182). Felsic minerals are largely primary/relict igneous, but polygonized zones between larger igneous crystals are common. Plagioclase is weakly to strongly zoned. K-feldspar is a mixture of microcline and perthite. Biotite varies from olive-green to orange-brown and is extensively chloritized in several samples. Blue-green to dark-green amphibole (mostly relict) is present in five of the thin sections and relict clinopyroxene in one (CG79-613). Accessory minerals are an opaque oxide (sulphide in CG79-613), apatite, titanite (typically mantling the opaque oxide, zircon (some with distinct rims), allanite (cores to epidote in part), and fluorite (CG79-295B, CG79-300, CG79-311). Late-stage or secondary white mica, chlorite, and epidote are sporadically present. An amphibolite enclave was also examined in thin section (CG79-295C). Its mineral assemblage includes relict igneous clinopyroxene.

*Alliuk Bight non-megacrystic granitoid rocks.* The Alliuk Bight granite is situated west of the Alliuk Bight megacrystic unit, close to the Cape Rouge non-megacrystic granitoid unit, with which it has similarities. The rocks are mostly granite to alkali-feldspar granite. They are pale-pink to white-weathering, coarse grained, and vary from massive to strongly foliated. Grain size exceeds 1 cm, in places. and K-feldspar locally over 2 cm (*i.e.*, verging on megacrystic). The granite is intruded by mafic dykes.

Only one sample was examined in thin section (CG79-748A). It is a leucogranite, almost devoid of mafic silicates (<0.1% biotite), and having an accessory mineral assemblage that is restricted to an opaque mineral, zircon and fluorite. It is assumed to be a product of more advanced fractionation of the granite.

### 6.4.3 GRANITOID INTRUSIONS SOUTH OF THE CAPE HARRISON DOMAIN

The rocks addressed in this section occupy a geological no-man's-land between established Makkovik Province rocks to the north and Groswater Bay terrane granitoid gneiss to the south. The author's bias is that they are probably southward extensions of late Makkovikian granitoid rocks caught up in a 'thick-skinned-style' tectonized zone that is at least partly Grenvillian; but such remains to be demonstrated.

The rocks have been organized into six units. From west to east, these are: i) White Bear Lake granitoid rocks, ii) Lake Michael granitoid rocks, iii) South of Tessialuk Pond granitoid rocks, iv) South of Byron Bay granitoid rocks, v) Alliuk Bight (south) megacrystic granitoid rocks, and vi) Smokey area granitoid rocks. It needs to be kept in mind that the entire inland region is very poorly exposed, so all regional interpretation is tentative at best. All the names are newly used here, and apply to areas rather than convincingly delineated rock bodies.

#### 6.4.3.1 White Bear Lake Granitoid Rocks ($P_{2C}$gr)

The White Bear Lake granitoid rocks occupy an east-striking lensoid area about 80 km long by a maximum of 15 km wide, defined to the north and south by inferred thrusts, north of which are the Big River granitoid rocks of the Makkovik Province, and south of which are the Groswater Bay terrane granitoid gneisses. The area was mapped by Stevenson (1970; part of his quartzofeldspathic gneiss Unit 4), and selected parts re-examined by Bailey *et al.* (1979), Gower (1981) and Gower *et al.* (1982a). Because of very poor exposure, it remains partly a matter of conjecture as to the nature of the bedrock in this area. It has high positive magnetic relief, more like the Makkovik Province to the north than the Groswater Bay terrane to the south (Figure 5.8).

The only geochronological data for this unit is a never formally published Geological Survey of Canada (GSC) K–Ar biotite date of 1272 ± 45 Ma (recalculated) from a granitic gneiss sample collected by I. Stevenson (his site

SG68-080). The date is indicated on GSC Map 1265A (Stockwell, 1982), and the author was provided with location and other details by the GSC geochronology laboratory. The date is unlikely to reflect time of emplacement. It was interpreted by Gower (2003) to mean that there was some Ar loss, but that the Grenvillian 1000 Ma 'thermal threshold' was not reached in this area.

Of the 25 outcrops included in the unit, about 80% are termed granite in field notes of various mappers. The rocks are typically described as pink-weathering, coarse-grained, strongly to very strongly foliated biotite granite. A medium-grained, sugary textured, strongly foliated granitoid rock having lenticular K-feldspars up to 1 by 0.5 cm was recorded near the eastern end of the unit.

Attesting to severe deformation (at least locally) is a strong lineation in outcrop at N68-125 and, 4 km along strike, 'pencil-like' structures at SG68-047. Further evidence of strong deformation is demonstrated by isoclinally folded mafic sheets assigned to Michael gabbro intruding the granite (these folds are obvious on aerial photographs). Also present are fine-grained quartzofeldspathic rocks (termed, by various mappers, as gneiss, 'metaquartzite' or 'like volcanic rocks [Aillik Group] to the north' (N68-167, SG68-080, SG68-302, SG80-303, SG68-304). Some of the outcrops are collectively aligned east-northeast parallel to regional strike. Garnet is present at SG68-304. Amphibolite enclaves up to several metres long (CG79-404), or smaller mafic lenses (CG83-629, SG68-043), were also noted. Mafic dykes (CG83-626, CG83-631) and various isoclinally folded quartzofeldspathic veins are present (CG83-628, SG68-043).

Three thin sections are available. All have polygonal fabrics. One (AL78-216) is fine grained and lacks indication of having recrystallized from a coarse-grained rock, and is likely a supracrustal rock. The other two (CG79-407, CG83-631) are fine to medium grained, and have somewhat more heterogeneous textures and more pronounced foliation, which may imply incomplete recrystallization from a coarse-grained granitoid protolith. All have plagioclase, K-feldspar (mainly microcline) and quartz. Biotite is orange-brown in AL78-216 and olive-green in the other two. Sample AL78-216 is also distinct from the others in lacking accessory minerals, except for secondary titanite, chlorite, epidote and white mica. The other two have an opaque oxide, apatite, zircon, allanite, and (in CG83-631) fluorite.

Gower (2010a; Big River map region) shows a small area of supracrustal rock (designated $P_{2C}$sq) in the White Bear Lake unit. Unit depiction here relies largely on Stevenson's field identification of metaquartzite at his data station SG68-304, which includes mention of garnet. Stevenson's site is 1 km east-northeast of AL78-216, and both are on strike with some of the other localities where fine-grained felsic rocks were recorded. Evidence is tenuous, but it does hint at the potential existence of an extensive fine-grained quartzofeldspathic unit. Insufficient information is available to judge what the origin of these rocks might be – felsic volcanic rocks or mylonitized granitoid rocks are obvious possibilities.

#### 6.4.3.2 Lake Michael Megacrystic Granitoid Rocks ($P_{2C}$gp)

The Lake Michael megacrystic granitoid rocks occupy an east-trending lenticular area about 90 km long by a maximum of 9 km wide, tapering westward, and defined to the north and south by inferred thrusts, north of which are the 'South of Tessialuk Pond granitoid rocks' (*see* next section), and south of which are the Groswater Bay terrane granitoid gneisses. The area was mapped by Stevenson (1970; part of his quartzofeldspathic gneiss Unit 4), and remapped by Gower (1981). Like the White Bear Lake area to the west, rock exposure is very sparse and the nature of the bedrock poorly known. Unlike the White Bear Lake area, it does not have such consistently high positive magnetic relief, although a few parts are equally prominent.

The rocks are recorded in field notes as pink-, buff-, or light-grey-weathering, medium- to coarse-grained granodiorite, granite and quartz monzonite. Stained slabs confirm that this diversity exists. In addition, there is textural variability resulting from heterogeneous deformation, producing rocks that were recorded as moderately, strongly, or very strongly foliated, or mylonitic. Quartzofeldspathic segregations, indicating incipient migmatization, add to the fabric mix locally. The unifying feature that the K-feldspar megacrysts provide is partly offset by their own heterogeneity. They are mostly fairly small (2 by 1 cm), but reach up to 4 by 2 cm. With increasing severity of deformation, they vary from euhedral, to augen, to lenticles. Scarcity is more typical than abundance. It is likely that, in many cases, the K-feldspar megacrysts are porphyroblasts and/or porphyroclasts. Lenticular K-feldspar megacryst stretching is matched by very elongate quartz. Other features include amphibolite enclaves (CG79-689), deformed mafic dykes (CG79-403, CG79-536), and a variety of deformed minor granitoid intrusions.

Ten thin sections from eight localities (AD79-298, AL78-195, AL78-237.1, AL78-237.2, CG79-403, CG79-448, CG79-530, SG68-205.1, SG68-205.2, SGJ68-114) are illustrative of the variability of the unit. All contain plagioclase, K-feldspar (microcline and perthite), quartz, olive-green to buff-brown biotite, an opaque oxide (except CG79-403), apatite, titanite, allanite and epidote (titanite mantles the opaque mineral and epidote mantles allanite). Thin sections from six localities have amphibole, which is typically blue-green, but some dark-blue-green sodic amphibole is present in AL78-195 and SGJ68-114. Epidote, allanite, titanite, biotite and an opaque mineral are partially the product of amphibole breakdown. Allanite is unusually large and abundant in AL78-195 – a quartz monzonite to quartz syenite that may well be a representative of an unrelated granitoid body. So might be alkali-feldspar granite SGJ68-114. Despite features in common, the two sites are 17 km apart so there is little incentive to link the two conceptually.

### 6.4.3.3 South of Tessialuk Pond Granitoid Rocks ($P_{2C}ya$)

The syenitic and granitic rocks south of Tessialuk Pond (*a.k.a.* Jay Lake), occupy an east-trending area almost 50 km long, but only up to 4 km wide. It is bounded to the north by the Tessialuk Pond felsic volcanic rocks and is in inferred thrust contact with the Lake Michael megacrystic granitoid unit to the south. The area was mapped by Stevenson (1970) as part of a quartzofeldspathic gneiss unit (his Unit 6). The unit was first distinguished from the surrounding granitoid rocks by Gower (1981; his Unit 25). Kerr (1989a, 1994) grouped the bulk of these rocks as part of an unassigned granitoid unit, but distinguished another syenitic body, 5–10 km farther west, which might be correlative (Thunder Mountain syenite). No geochronological data are available for the unit and is just a guess that the rocks belong to the 1800–1790 Ma event; the next most likely possibility being the 1720 Ma event.

Although the Tessialuk Pond granitoid rocks are divided by Gower (2010a; Benedict Mountains map region) into syenitic, granitic, monzonitic and megacrystic subunits, all are collectively addressed here, as the distinctions appear to be nuances rather than having much individual significance. The rocks are pink-weathering and were originally coarse grained. Strong deformation is a key feature of the unit, not only creating the dark, comminuted matrix, but also being responsible for the feldspar porphyroclasts and ribbon quartz (up to 3 cm long by 1–2 mm wide). The dark matrix may explain why some of the rocks were termed monzonite in the field (a misnomer dispelled by rock staining). Some of the feldspar porphyroclasts (typically 1.5 by 1 cm, but up to 3 by 2 cm) show alternating K-feldspar-plagioclase growth zones (pseudo-rapakivi texture; *e.g.*, CG79-441), and may reflect an originally megacrystic texture. Other features of the unit include sporadic quartzofeldspathic segregations and fine-grained felsic enclaves that may have been derived from volcanic rocks (SG68-122). More continuous zones of fine-grained syenite and granite may represent sheared minor felsic intrusions. Mafic enclaves averaging about 10 by 6 cm, but up to 1 m by 20 cm were recorded at CG79-690. The unit is intruded by mafic dykes that crosscut a foliation, but are themselves foliated and metamorphosed (AD79-268).

Three syenitic rocks (CG79-441, DB79-245, DB79-248), three granite samples (CG79-680, CG79-683, CG79-691) and one monzonite (CG79-679) were examined in thin section. All contain plagioclase, K-feldspar (microcline and/or perthite), quartz, biotite (mostly olive-green to green-buff), an opaque mineral, apatite, titanite, and allanite. Green or blue-green amphibole and zircon are present in some thin sections, although zircon may have been overlooked in those where it was not seen. Garnet is present in CG79-680. Secondary minerals are biotite, epidote, chlorite and white mica. The most striking feature of all the thin sections is the mylonitic fabric. Felsic minerals, where not retained as porphyroclasts, are comminuted, sutured aggregates, and the mafic and accessory minerals are mostly reduced to veneers wrapping around them. Despite intense deformation, the grade of metamorphism is not high – roughly upper greeenschist facies – because even amphibole is not stable, preserved only as ragged, porphyroclastic remnants.

### 6.4.3.4 South of Byron Bay Granitoid Rocks ($P_{2C}gr$)

The ‘South of Byron Bay’ granitic rocks occupy a lens-shaped area, elongate in an east–west direction, that is almost 50 km long, and up to 10 km at its widest. It is bounded to the west by the Lake Michael megacrystic granitoid rocks, to the north and east by the Benedict fault, to the south (east half) by the Alliuk Bight (south) megacrystic granitoid unit and to the south (west half) by Groswater Bay terrane gneiss. The nature of contacts is largely unknown, but likely to be thrusts. The area was mapped by Stevenson (1970) as quartzofeldspathic gneiss (his units 4 and 6). The rocks were remapped by Gower (1981; his Unit 27) and termed foliated to gneissic granodiorite. Following staining and petrographic studies, it is concluded that granite is more common than granodiorite, although granodioritic rocks (and megacrystic variants) form an envelope around a small (3 by 2 km) remnant of felsic volcanic rocks. Minor quartz monzonite is also present. No geochronological data are available for the unit.

The rocks are pink-, white- or buff-weathering, coarse grained and weakly to strongly foliated, or, in places, mylonitic. Some of the rocks show incipient migmatization (CG79-626 and DB79-254), and hints of a former K-feldspar seriate to megacrystic texture. Mafic enclaves, bands, lenses or schlieren are locally present, and recorded as numerous at DB79-234. Deformed mafic dykes were also noted.

Thin sections are equally divided between granite (CG79-535, CG79-556, CG79-594) and granodiorite (CG79-554, CG79-564, SGJ68-080). Minerals in common are plagioclase, K-feldspar (microcline and/or perthite), quartz, olive-green biotite (orange-brown in granodiorite samples CG79-554 and SGJ68-080), an opaque oxide, apatite, zircon, titanite, and allanite. Blue-green relict hornblende is present in CG79-554 and SGJ68-080, and clinopyroxene in CG79-554. Garnet was noted in hand sample CG79-556.

### 6.4.3.5 Alliuk Bight (South) Megacrystic Granitoid Rocks ($P_{2C}gp$)

It is tempting merely to consider the ‘Alliuk Bight (south) megacrystic granitoid rocks’ as a southward and westward continuation of the already described Alliuk Bight megacrystic granitoid rocks. Such might well be the case, but their separation is maintained here as the two regions may be divided by a major structure – the Benedict fault. As the relationships between these two groups of megacrystic granitoid rocks depend considerably on the significance of the Benedict fault, a digression is necessary to address the issue.

The position of the Benedict fault is somewhat elusive at its eastern end (in contrast to its well-defined location farther west). Stevenson (1970) does not indicate the Benedict fault as continuing through this area at all, showing both the Alliuk Bight megacrystic granitoid rocks and the Alliuk Bight (south) megacrystic rocks as part of a single unit of granitic rocks (his Unit 7). West of Alliuk Bight, Stevenson (1970) mapped parts of what is grouped here as Alliuk Bight (south) megacrystic granitoid rocks as quartzofeldspathic gneiss (his units 4 and 6). Gower (1981) adopted Stevenson's boundary between granitoid rocks and quartzofeldspathic gneiss as defining the position of the Benedict fault in this region. In a more detailed study, Owen (1985) located the Benedict fault about 6 km north of where Gower (1981) placed it, and, in so doing, depicts it passing through the Alliuk Bight megacrystic granitoid rocks and the Brig Harbour Island mafic intrusion. This location is coincident with a major aeromagnetic linear feature and is on line with a major shear zone on Pigeon Island. Gower (2010a; Byron Bay map region) positioned the Benedict fault close to his original location except at its eastern end, where it is positioned to be coincident with other faults mapped by Owen (1985), and with the Pigeon Island shear zone. This position brings it south of the Brig Harbour Island mafic intrusion and coincident with the boundary between weakly deformed megacrystic granitoid rocks to the north *vs.* strongly deformed potential equivalents to the south, that is to say between Gower's (1981) granitoid Unit 19 and his gneissic granitoid Unit 28. In short, it remains very uncertain as to the nature and significance of the Benedict fault, and thus complicating understanding of the affinities of the various megacrystic granitoid rocks in the area.

Two U–Pb monazite analyses provide the only quantitative constraint on the age of the Alliuk Bight (south) megacrystic granitoid rocks (Krogh *et al.*, 2002). A medium- to coarse-grained, strongly foliated, sparsely K-feldspar megacrystic granodiorite from Pigeon Island (sample V192, same site as CG79-317) yielded one 2% discordant $^{207}$Pb/$^{206}$Pb date of 1641 ± 4 Ma (interpreted as the minimum age of metamorphism) and one above-concordia $^{207}$Pb/$^{206}$Pb date of 1694 ± 8 Ma. For the latter point, the mean Pb/U age of 1709 ± 10 Ma was considered a reasonable maximum estimate for the time of metamorphism. The age of the protolith remains unconstrained, other than at least *ca.* 1700 Ma.

The rocks are variously termed in field notes as granodiorite, granite or quartz monzonite. They are pale-grey, buff- or pink-weathering, medium- to coarse-grained, and moderately foliated to intensely mylonitic. Overall, the rocks have a foliated to gneissic appearance, but include both homogeneous rocks and fairly well-banded gneiss. In the gneiss, banding is defined by concordant quartzofeldspathic segregations, pegmatite, microgranite and aplite, rather than distinct leucosomes and melanosomes. A pronounced linear fabric may also be present. Severe deformation tends to be confined to specific zones, in which the rocks display a dark, comminuted groundmass. K-feldspar megacrysts are sparse to abundant, and are commonly broken relicts or ellipsoidal/lenticular augen. Typically less than 2 cm long, they were recorded as being up to 5 by 4 cm. Associated rock types include amphibolite bands, or, less commonly, syenitic (AD78-230) and ultramafite (AD79-232) xenoliths. The rocks are invaded by ptygmatic quartzofeldspathic veins, severely deformed mafic dykes (including net-veined dykes), and discordant pegmatite.

> Five thin sections were examined (CG79-317, CG79-320, CG79-579, CG79-591, CG79-611). All show the effects of severe deformation, resulting in broken, porphyroclastic fragments of plagioclase and K-feldspar (microcline and perthite), and highly sutured quartz aggregates in a matrix of comminuted, fine-grained recrystallized aggregates of felsic minerals, associated with orange-green biotite and accessory minerals. The accessory phases include blue-green amphibole (in CG79-611 only), an opaque mineral, apatite, titanite, zircon, and allanite. Most accessory phases are absent from CG79-317, which has white mica and epidote as the main non-felsic minerals. These are also sporadically present in other thin sections. The mineral assemblages indicate that the metamorphic grade at time of deformation was modest (upper greenschist facies). The deformational contrast to the Alliuk Bight megacrystic rocks farther north is striking and provides strong support for major shear zones in the area.

#### 6.4.3.6 Smokey Area Granitoid Rocks ($P_{2C}$gp, $P_{2C}$gd, $P_{2C}$gr, $P_{2C}$mz)

Granitoid rocks in the Smokey area form an east-trending area 50 km long by up to 12 km wide, plus a small isolated segment about 10 km west of the main area. The rocks are separated from the Alliuk Bight (south) megacrystic granitoid rocks to the north by the Cutthroat Island thrust and are in contact (which is assumed to be a fault or thrust) with the Groswater Bay gneiss to the south. Excluded from this summary is the earlier-reviewed White Bear Islands granulite complex (WBIGC), with which the Smokey area granitoid rocks are closely spatially associated. Both were assigned to a single unit by Stevenson (1970; his granitoid gneiss Unit 6), and by Gower *et al.* (1983b; part of their granitoid gneiss Unit 1). The WBIGC was distinguished from the Smokey area granitoid rocks by Owen (1985). Owen correlated the Smokey area granitoid rocks with the Alliuk Bight and Alliuk Bight (south) megacrystic granitoid units, all being grouped as the now-obsolete Benedict Mountains Intrusive Suite.

The maximum age of the Smokey area granitoid rocks is constrained to no more than 1799 +3/–2 Ma. This conclusion relies on a U–Pb zircon age obtained from the WBIGC, which is intruded by the Smokey area granitoid rocks (Krogh *et al.*, 2002; site CG92-065). At a second site (Cutthroat Island thrust; CG92-066), Smokey area granitoid rocks are interpreted to be the mylonitized precursor. A single zircon overgrowth from this rock type yielded a concordant date of 1790 ± 2 Ma (Krogh, 1994). A weakly deformed pegmatite that postdates most of the mylonitic deformation yielded an age of 1730 ± 2 Ma, based on two concordant zircon analyses. The age of the Smokey area granitoid rocks is therefore bracketed between *ca.* 1800 and 1730 Ma.

The rocks are termed in field notes as quartz diorite, quartz monzodiorite, quartz monzonite, tonalite and granodiorite, and, rarely, granite. They are grey to (less commonly) pink-weathering, mostly medium to coarse grained (some fine-grained rocks are also present), and moderately to strongly foliated, grading into well-banded gneiss. Mylonitic shear zones are present. Many of the rocks are seriate to mildly megacrystic, giving the rocks a knotted surface appearance. The megacrysts range from euhedral to lenticular augen. Typical size is 1.5 by 1 cm but up to 4 by 2 cm was recorded. Garnet is common, up to about 4 mm in diameter. The rocks are also characterized by concordant amphibolite boudins, lenses and lenticles. These carry K-feldspar megacrysts and garnet. Severely buckled quartzofeldspathic veins are common. Separate from the concordant amphibolite are discordant strongly and weakly deformed mafic dykes. A few weakly deformed pegmatitic veinlets are present.

Seven thin sections sample the granitoid area's full east-west extent (CG79-336, CG79-349, CG79-357, CG92-066A, SGJ68-106, SGJ68-109, VO87-192). The mineral assemblage in all sections includes plagioclase, microcline, quartz, olive-green to orange-brown biotite, blue-green to green amphibole (CG79-357, CG92-066A, VO87-192), garnet (CG79-349, which is the most southerly sample), an opaque oxide, apatite, titanite (mantling the opaque phase), zircon, allanite (in part cores to epidote), and white mica. Relict igneous feldspar is present, but the fabric is typically recrystallized, planar and well defined.

## 6.5 POST-MAKKOVIKIAN GRANITOID ROCKS IN THE CAPE HARRISON DOMAIN (*ca.* 1720 Ma)

Kerr *et al.* (1992) identified a 1720-Ma posttectonic plutonic assemblage in the Makkovik Province. No representatives have been dated within the Cape Harrison domain, and assigning them to this unit depends on correlation by composition. The rocks can be divided into two groups, namely: i) alkali-feldspar syenite and ii) granite to alkali-feldspar granite (Figure 6.5; Appendix 2, Slab images 6.4).

### 6.5.1 ALKALI-FELDSPAR SYENITE

Three bodies are included here, namely: i) Ragged Islands alkali-feldspar syenite, ii) Tilt Cove alkali-feldspar

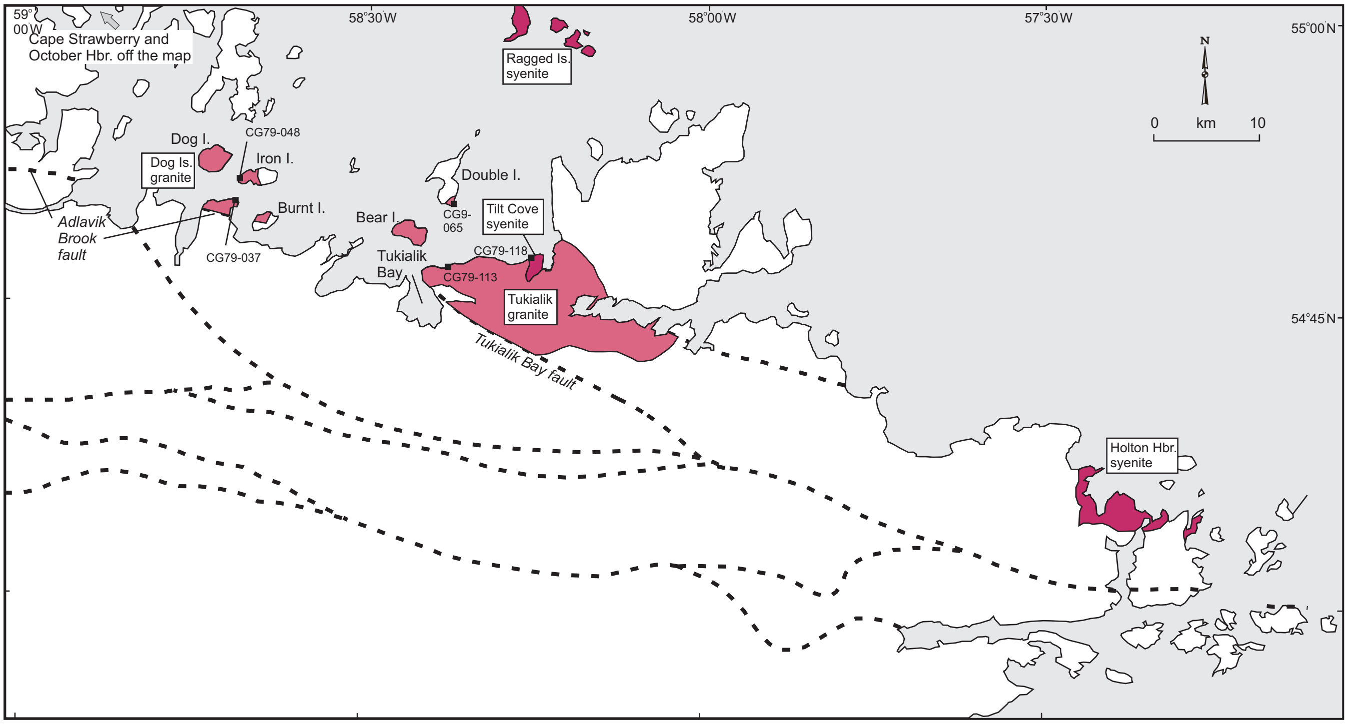

**Figure 6.5.** *Post-Makkovikian granitoid rocks in the Cape Harrison domain.*

syenite, and iii) Holton Harbour syenite to alkali-feldspar granite. The Ragged Islands and Tilt Cove intrusions have been designated Unit $P_{2C}$ya (*ca.* 1800 Ma) on Gower's (2010a) 1:100 000-scale maps, whereas the Holton Harbour body was assigned Unit $P_{3C}$yq (*ca.* 1650 Ma). That all three are grouped together here is, of course, an inconsistency, but it reflects the author's ambivalence regarding a common affinity that the three bodies might share.

#### 6.5.1.1 Ragged Islands Alkali-feldspar Syenite ($P_{2C}$ya)

The Ragged Islands, over 10 km off the coast of mainland Labrador, owe their existence to the very durable rock from which they are made. The distinctiveness of the bedrock was recognized by Christie *et al.* (1953), Kranck (1953) and Stevenson (1970), who all depict the islands' bedrock as syenite, in contrast to the granite and granitic gneiss that prevail elsewhere in the region. Subsequent examination of the rocks was made by Gower (1981). Note that Kerr (1989a, 1994) did not include the Ragged Islands in his study, but he interpreted it to be part of his *ca.* 1800 Ma Numok Intrusive Suite. No isotopic data are available for the intrusion.

The rocks are rusty-, brown- or chocolate-weathering, massive, homogeneous, inequigranular and coarse grained (K-feldspar laths >1 cm). A few mafic enclaves were recorded. Kranck (1939) noted that the rocks resemble the dark varieties of Scandinavian rapakivi granites (which, currently, would probably be called ferrodiorite).

Thin sections CG79-511 (from a site where, inconsequentially, the author left a camera that, presumably, is still there), and SGJ68-136 show the rocks to consist overwhelmingly of K-feldspar, which includes both perthite and microcline (Stevenson, 1970, estimated 65% K-feldspar modal abundance). Other minerals are quartz, plagioclase, orange-red biotite, green-brown hornblende, pigeonite, an opaque oxide, apatite, and zircon (large and abundant in SGJ68-136).

#### 6.5.1.2 Tilt Cove Alkali-feldspar Syenite ($P_{2C}$ya)

The Tilt Cove alkali-feldspar syenite is shown on the maps of Christie *et al.* (1953), Stevenson (1970) and Gower (1981), but not that of Kranck (1953). The rock is grey-brown weathering, coarse grained, massive and equigranular. Gower (field notes – CG79-118) noted blue quartz, and Stevenson (assistant J. Bourne field notes – SGJ68-140) made comparison with the rocks on Ragged Islands. No isotopic data are available. The syenite is intruded by a net-veined composite mafic–felsic dyke (Plate 6.6).

Thin sections (CG79-118B, SGJ68-140) show the rock to consist of perthitic K-feldspar, minor quartz, orange-brown biotite, dark-green sodic amphibole, apple-green clinopyroxene (*cf.* aegerine), opaque oxide and sulphide, apatite, titanite, zircon, and fluorite.

#### 6.5.1.3 Holton Harbour Syenite to Alkali-feldspar Granite (on Map as[2] $P_{3C}$yq)

The Holton Harbour syenite is located in the eastern part of the Makkovik Province and has an equivocal spatial association with the West of Brig Harbour layered mafic intrusion, with which it may be genetically linked. The unit was first recognized by Christie *et al.* (1953), who distinguished massive syenitic rocks from the surrounding granite. Neither Kranck (1953) nor Stevenson (1970) indicates these syenitic rocks on their maps. The syenitic rocks were subsequently mapped by Gower (1981; his Unit 24) and, in more detail, by Owen (1985; his Unit 9).

Gower (1981) described the rocks as distinctively chocolate-brown-weathering, coarse grained, and intruded as sheets and irregular bodies. The rocks are mostly equigranular and massive, but some outcrops display crude layering (*e.g.*, CG79-275). A few outcrops contain enclaves of finer grained syenite. Owen (1985) termed the rocks fer-

**Plate 6.6.** *Tilt Cove alkali-feldspar syenite intruded by mafic–felsic composite dyke (CG79-118).*

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[2] 'On map as' refers to Gower's (2010a) 1:100 000-scale maps.

rodiorite to ferrosyenite and also mentioned the presence of igneous layering. Both authors reported field evidence indicating the syenite to be younger than the surrounding granitoid rocks. Gower recorded shear zones in the host rocks that are truncated by the syenite. Owen (1985) mentioned enclaves of hornblende-biotite monzonite (seen elsewhere in the area) within the syenite and that dykes of syenite crosscut fabrics in the host rocks.

Two attempts, using Rb–Sr isotopic methods, have been made to date the syenite. Brooks (1982a) initially obtained an errorchorn of 1725 ± 134 Ma ($I_{Sr}$ = 0.7024) based on four samples supplied by the author. In an attempt to refine this result, three additional samples were analyzed by Brooks (1982b). The new data showed considerable scatter and no better indication of age, although did suggest a Grenvillian influence. The second attempt was by Owen (1985), who reported a 7-point errorchron of 1676 ± 77 Ma ($I_{Sr}$ = 0.7020). No other isotopic data are available for the body.

Five thin sections were prepared for the author (AD79-221, CG79-275, CG79-279, CG79-282, N68-086). Additional thin sections were separately obtained and examined by Owen (1985). The following description is composite from both sources (modal data and mineral compositions being provided by Owen, 1985). The rocks consist of antiperthitic microcline (35–70%); sodic plagioclase ($An_{1-5}$; 5–20%); quartz (2–15%); clinopyroxene ($Wo_{46}$:$En_3$:$Fs_{51}$ – sample V341-1; 5%); orange, green or buff biotite (0–5%); blue-green hornblende (1–6%); opaque oxides (1–3%), apatite, zircon, allanite, titanite (mantling opaque oxides) and fluorite.

### 6.5.2 GRANITE AND ALKALI-FELDSPAR GRANITE

Kerr (1994) classified posttectonic Makkovikian plutonic rocks in the Makkovik Province into three suites, namely: i) Numok Intrusive Suite, ii) Lanceground Intrusive Suite and iii) Strawberry Intrusive Suite. In addition, he identified three other granitoid bodies that he considered should be included as post-Makkovikian plutonic rocks, although not belonging to the above-mentioned suites. These are the Freshsteak Lake granitoid, the Noarse Lake granitoid, and the Big River granitoid. The Numok Intrusive Suite and Big River granitoid rocks are reassigned as late-tectonic (*see* earlier). Part of the Lanceground Intrusive Suite (south of Adlavik Bay) also occurs within the area included in the report, but is not addressed here as the author has not seen it and cannot add to the comprehensive description already given by Kerr (1989a, 1994).

The Strawberry Intrusive Suite includes the Strawberry granite of Kranck (1939), who was perhaps the first to recognize the posttectonic nature of the intrusion. As defined by Kerr (1989a, 1994), the Strawberry Intrusive Suite embraces several distinct plutons over an east–west distance of 125 km. From east to west, these are the Tukialik, Dog Islands, Cape Strawberry and Bayhead granites, to which, even farther west, the Blacklers Bight granite may now be added (1716 ± 1 Ma; Ketchum *et al.*, 2001a). Only the Tukialik and Dog Islands granites fall within the region considered here, but all are shown on Figure 5.3 (as 1720–1715 Ma plutons).

The Cape Strawberry granite has yielded a near-concordant zircon age of 1719 ± 3 Ma (Kerr *et al.*, 1992), and also K–Ar biotite ages (recalculated) of 1570 ± 50 Ma (Gandhi *et al.*, 1969) and 1605 ± 34 Ma (Wanless *et al.*, 1970). A composite Rb–Sr whole-rock isochron (Kerr, 1989a) from four plutons of the Strawberry Intrusive Suite (Cape Strawberry granite, Bayhead granite, Dog Islands granite and Tukialik granite) has an age of 1694 ± 56 Ma ($I_{Sr}$ = 0.69790). Kerr (1994) notes that this is within error of the U–Pb age, but that a low $I_{Sr}$ value implies isotopic disturbance. The U–Pb age more-or-less endorses correlation with the slightly older rapakivi suite in Greenland, which has an indicated emplacement time span of 1755–1723 Ma (Garde *et al.*, 2002). This correlation was originally suggested by Kranck (1939), and has been iterated subsequently (*e.g.*, Ketchum *et al.*, 2001a). Gower (2010a; Bryon Bay and Mount Benedict map regions) groups the Dog Islands granite and Tukialik granite as Unit $P_{2C}$ga, which implies a pre-1800 Ma age. Although not yet demonstrated to be erroneous, it likely is, so a better designator would be $P_{3A}$gr (or a to-be-created Unit $P_{3A}$ga).

Although the Strawberry Intrusive Suite is considered a genetic entity in this report there is an important caveat that brings this concept into question. The caveat pertains to reported LAM–ICP–MS ages of 1657 ± 10 Ma (zircon) and 1635 ± 17 Ma (allanite) from the October Harbour granite (Cox *et al.*, 2003). The October Harbour granite is situated east of the Cape Strawberry granite and can be located on Figure 5.3 by its 1657 ± 10 Ma date. The October Harbour granite was included in the Strawberry Intrusive Suite by Kerr (1989a, 1994) and, earlier, by Gower *et al.* (1982a) on the basis of mineral assemblage and previous visual comparisons made by Gandhi *et al.* (1969) and Cooper (1951). Given that Gower *et al.*'s and Kerr's assigning of the October Harbour granite and other granitoid bodies in the Strawberry Intrusive Suite was also done partly on the basis lithogeochemical data, means that the grouping of all bodies in this suite using this approach is suspect; some could be Labradorian (Cox *et al.*, 2003).

#### 6.5.2.1 Dog Islands Granite ($P_{2C}$ga)

The name 'Dog Islands granite' was introduced by Kerr (1989a, 1994). The granite was first correlated with the Cape Strawberry granite by Kranck (1939), and later mapped by Stevenson (1970, his Unit 7) and Gower (1981, his units 17 and 18). J. Bourne (Stevenson's assistant), in field notes, also recorded a close resemblance of the rock with the Cape Strawberry granite.

The Dog Islands granite forms the bedrock to Dog Island, Iron Island, Burnt Island, and the adjacent mainland, giving the pluton a minimum size of about 10 by 6 km, elongate in an east-southeast direction. The granite is typically pale-pink-weathering, coarse grained and massive (Plate 6.7A), but has a slightly darker pink, medium- to coarse-grained, syenitic to granodioritic compositional variant in its eastern part. Gower's field notes record K-feldspar up to 3 cm long, plagioclase reaching 2 cm long, quartz 2 cm across (characteristically clear and unrecrystallized), and mafic mineral clusters (mostly biotite) up to 0.7 cm long. Fluorite is common, some in pegmatitic patches. A common feature of the rock is the presence of swirly, diffuse, mafic-mineral-enriched skialiths that suggest flowage and gravity fractionation in a viscous magma. Some resemble, and may represent, igneous crossbedding (Plate 6.7B). Kerr (1989a, 1994) also interpreted them to be cumulus features. Also present are sparse, ellipsoidal enclaves of mafic to intermediate plagioclase–biotite–hornblende material, generally less than 10 cm long, but, rarely, up to about 30 cm long.

The granite is also intruded by composite mafic–felsic, net-veined mafic dykes (CG79-038.2) that are, in turn, crosscut by minor granitoid intrusions, and then non-net-veined, flat-lying mafic dykes. The genetic relationship of these to the host granite is uncertain, but it seems likely that the net-veined dykes are the product of magma-mingling processes, in which case they could have been intruded during the waning stages of Dog Islands granite emplacement. The later minor granitoid intrusions could also have been emplaced during that phase, and may be allied with fluorite-bearing quartz-feldspar porphyry dykes that resemble Dog Islands granite and intrude the *ca.* 1800 Ma Numok Intrusive Suite (Kerr, 1989a, 1994). The non-net-veined, flat-lying mafic dykes might correlate with the subhorizontal Kokkorvik dykes farther northwest dated to be 1635 ± 47 Ma and 1640 ± 59 Ma (Rb–Sr, whole rock, Grant *et al.*, 1983 and Ermanovics *et al.*, 1982, respectively).

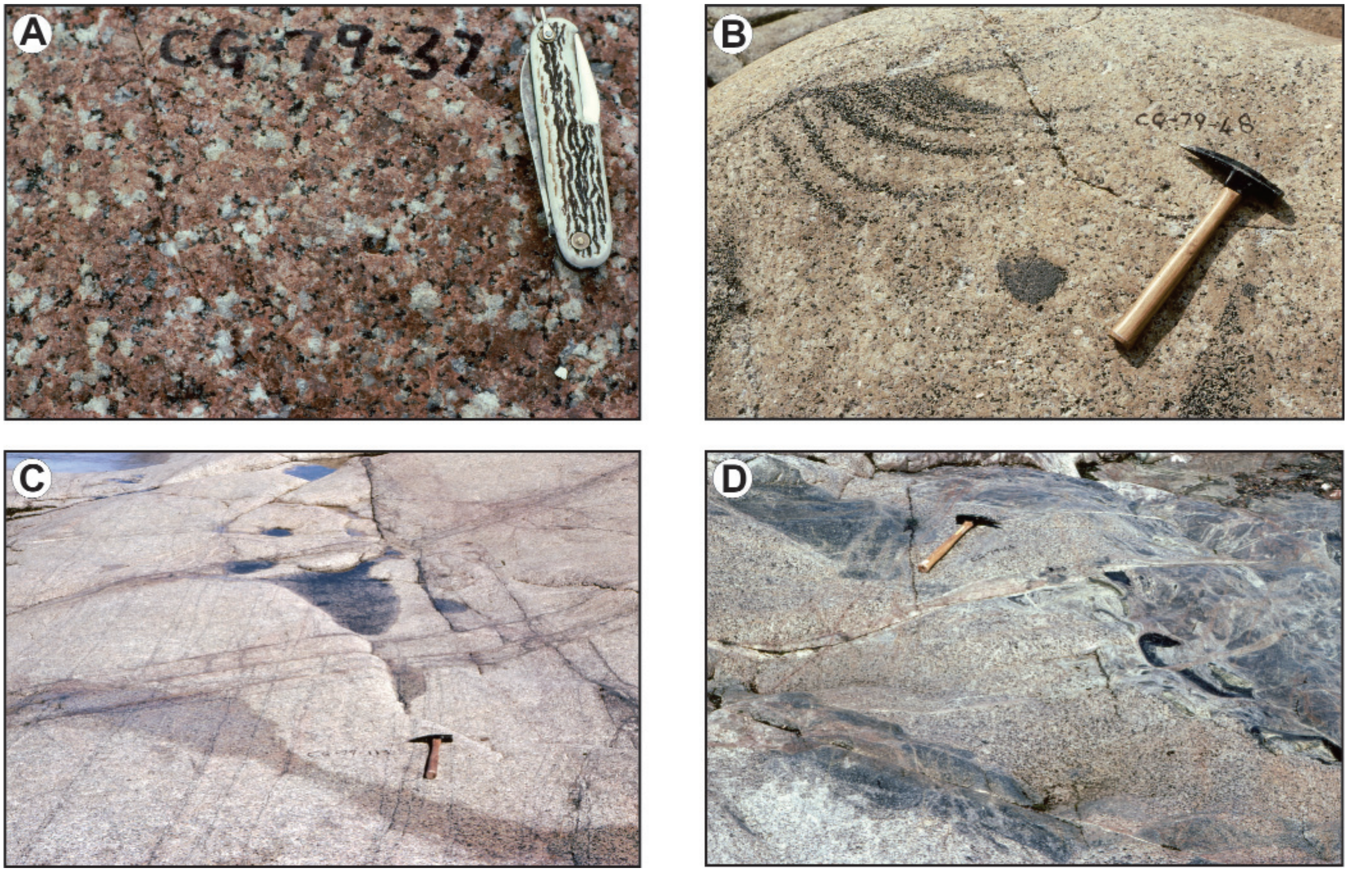

**Plate 6.7.** *Post-Makkovikian granitoid rocks in the Cape Harrison domain. A. Dog Islands granite (CG79-037), B. Dog Islands granite showing igneous crossbedding defined by biotite–hornblende concentrations (CG79-048), C. Tukialik granite crosscut by two sets of shears, but otherwise homogeneous (CG79-113), D. Agmatitic contact between Aillik Group correlative and interpreted Tukialik granite (CG79-065).*

In thin section (CG79-034, CG79-040B, CG79-042, CG79-047, CG79-048, CG79-051A), the granite is seen to consist of plagioclase, K-feldspar (microcline and relict perthite), green to buff biotite, minor relict dark-green hornblende (CG79-042, CG79-047, CG79-048), an opaque oxide, apatite, zircon, titanite, zoned allanite and fluorite (apatite, titanite and allanite lacking in CG79-034, and fluorite lacking in CG79-051A). In addition to the presence of fluorite, a characteristic feature of the samples is extensive chloritization of biotite. Kerr (1989a, 1994) reported a distinctive blue poikilitic amphibole (riebeckite or arfvedsonite) in one sample and clinopyroxene (suggested to be aegerine–augite) from another.

#### 6.5.2.2 Tukialik Granite ($P_{2C}$ga)

The Tukialik granite was named by Kerr (1989a, 1994), from Tukialik Bay (which has an alternative spelling of 'Tuchialik' on some older maps). The granite was not mapped separately by Kranck (1953) or Stevenson (1970), but was outlined by Gower (1981; part of his Unit 23 – no name assigned) east of Tukialik Bay, on Bear Island and at the southern tip of Double Island. It has a minimum size of 30 by 10 km, elongate in an east-southeast direction. The Tukialik granite is separated from the Dog Islands granite by 12 km of the Labrador Sea, which prevents knowing whether or not the two bodies are part of a single intrusion, but, as they differ somewhat in texture and composition, such is probably not the case.

The southern contact of the Tukialik granite is with the Labradorian Mount Benedict Intrusive Suite. The nature of the interface between the two units is mostly uncertain, but currently interpreted as a fault (eastward extension of the Adlavik Brook fault) in the west, and intrusive in the east. The typical granite is pale-pink, pale-buff, or white-weathering, coarse grained (*ca.* 1 cm grainsize), even textured, and massive to weakly foliated (Plate 6.7C). The fabric is likely primary away from the faulted southern contact where the rocks are strongly sheared, fractured, and altered (CG79-110). Progressing northward, the shearing diminishes and only fluorite-, epidote-, chlorite- and/or calcite-filled fractures are seen (*e.g.*, SGJ68-142). Other faults may transect the body, as sheared rocks are seen sporadically in its interior (*e.g.*, CG79-485). Mafic-mineral-rich enclaves or skialiths are generally sparse and small (10 by 4 cm). The granite is intruded by non-net-veined mafic dykes (ultramafic? at CG79-486), and some medium-grained, buff-pink microsyenitic and aplitic rocks (*e.g.*, CG79-061). A few dioritic enclaves have also been reported (DD79-048, DD79-049, DD79-051). At the southern tip of Double Island, Tukialik granite is in agmatitic contact with Aillik Group correlative felsic volcanic remnants (Plate 6.7D).

Thin sections of the Tukialik granite (CG79-059, CG79-063, CG79-088, CG79-113, CG79-477, CG79-482, CG79-484, CG79-487, CG79-513, N68-077) show it to be dominated by patch perthite (some microcline), with lesser undulose, but unrecrystallized quartz (locally blue in outcrop), and subsidiary saussuritized sodic plagioclase. The main mafic mineral is olive-green to dark-green, partly chloritized biotite. Ragged, relict, dark-green to blue-green hornblende is present in CG79-113, CG79-513, N68-077. The hornblende is mostly altered to biotite, chlorite, epidote, carbonate, opaque minerals and titanite. Fluorite is seen in the majority of samples and typically forms colourless isolated grains, although purple fluorite is present as spindles in altered biotite. Muscovite forms large flakes in CG79-088. Accessory minerals are an opaque oxide, apatite, titanite (zoned in places), zircon and allanite; some of these are secondary. Other secondary minerals are white mica, chlorite, and epidote. Crush zones, composed of comminuted, fine-grained, polygonised felsic minerals, are evident in a few samples.