CHAPTER 12

LATE LABRADORIAN GRANITOID INTRUSIONS (P_{3C} 1660–1600 Ma)

Late Labradorian granitoid intrusions that were not addressed in the previous chapter are labelled on Figure 12.1. The intrusions are reviewed by domain/terrane, commencing in the north. Representative stained slabs are presented in Appendix 2, Slab images 12.1 (Cape Harrison domain), 12.2 (Groswater Bay terrane), and 12.3 (Hawke River, Lake Melville and Mealy Mountains terranes).

12.1 CAPE HARRISON DOMAIN, MAKKOVIK PROVINCE

12.1.1 MOUNT BENEDICT INTRUSIVE SUITE

Rocks designated as Mount Benedict Intrusive Suite (Figure 12.2) were first mapped as a geological entity by Gower (1980, 1981), and, along with other granitoid rocks in the region, were included within his then newly coined 'Benedict Mountains Intrusive Suite'. Following U–Pb geochronological investigations in the region (Kerr and Krogh, 1990; Kerr *et al.*, 1992), it became clear that both Labradorian and Makkovikian plutonic rocks had been included in this 'suite', thus requiring terminology revision. In consequence, the name 'Mount Benedict Intrusive Suite' was proposed by Kerr (1989a), and published by Kerr and Krogh (1990), for Labradorian granitoid rocks that underlie the Mount Benedict area and farther east, that, mostly, correlate with Gower's (1981) Unit 21. As emphasized by Kerr (1989a, 1994), the term is not synonymous with 'Benedict Mountains intrusive suite' and, sensibly, Kerr recommended that the earlier-applied term be abandoned.

The earliest geochronological age obtained for the Mount Benedict Intrusive Suite was a K–Ar biotite result of 1585 ± 50 Ma (recalculated) from a sample collected by Stevenson (1970) and reported by Wanless *et al.* (1972; sample GSC70-136). A Rb–Sr whole-rock errorchron date of 1625 ± 50 Ma (I_{Sr} = 0.7016) was reported by Brooks (1982a), with the caveat that, given some high Rb–Sr values, the system was possibly disturbed. The errorchron is based on 8 samples, but if two high $^{87}Rb/^{86}Sr$ off-regression samples are excluded, then the date becomes 1665 ± 60 Ma (I_{Sr} = 0.6993). Subsequently, a U–Pb near-concordant zircon age of 1649 ± 3 Ma was obtained, based on two zircon fractions each from two samples (0242144, 0242125) collected from sites 3 km apart (Figure 12.2). The age relies on three of the four fractions, the excluded sample (0242144-1) interpreted to have possibly experienced multiple Pb loss events (Kerr *et al.*, 1992; age revised from Kerr and Krogh, 1990).

The Sm–Nd isotopic data were reported in preliminary form by Kerr (1989a) and later by Kerr and Fryer (1990, 1994). Kerr and Fryer (1990) provided two analyses, one of which is from mafic rocks excluded from the Mount Benedict Intrusive Suite in this report (*see* next section). Analytical data for the other sample were revised by Kerr and Fryer (1994) and augmented with two additional results. The three samples of Kerr and Fryer (1994) are T_{DM} = 2120, 2140 and 2220 Ma, and εNd (1.65 Ga) = –1.4, –2.0 and –3.9. The most negative εNd (1.65 Ga) = –3.9 sample is from a locality used for U–Pb dating (0242144), from which the non-regressed zircon result was obtained. Kerr and Fryer (1994) explained the εNd value as due to magma contamination by older (Archean) crustal material (which is consistent with the anomalous zircon data). It is also commented here that the site is only 1.5 km from the intrusion's western margin, close to the boundary between syenite and granite, and that Davidson and Kowalczyk (1979) distinguished the rocks in the vicinity as different from typical Mount Benedict Intrusive Suite. None of these considerations substantially challenge the suite's reported age, which hinges mostly on the more-concordant results from the other site (0242125).

The dominant rock type in the Mount Benedict Intrusive Suite was termed syenite to alkali-feldspar syenite associated with syenite and monzonite by Gower (1981). The suite was subdivided into three units by Kerr (1989a, 1994), namely: i) gabbro and diorite (his Unit 26), ii) monzonite, syenomonzonite and syenite (his Unit 27), and iii) syenite, quartz syenite and granite (his Unit 28). An approximate correlation between units depicted on Gower's (2010a) Benedict Mountains map region and Kerr's (1994) classification is made in the legend of Figure 12.2.

12.1.1.1 Gabbro and Diorite (P_{3C}rg, P_{3C}dr)

Kerr's gabbro and diorite unit is located in the southwest part of the Mount Benedict Intrusive Suite (just above the word 'zircon' in Figure 12.2), in an area included as part of Gower's (1981) Unit 21. Kerr does not indicate data stations on his maps and Gower's data stations are sparse in

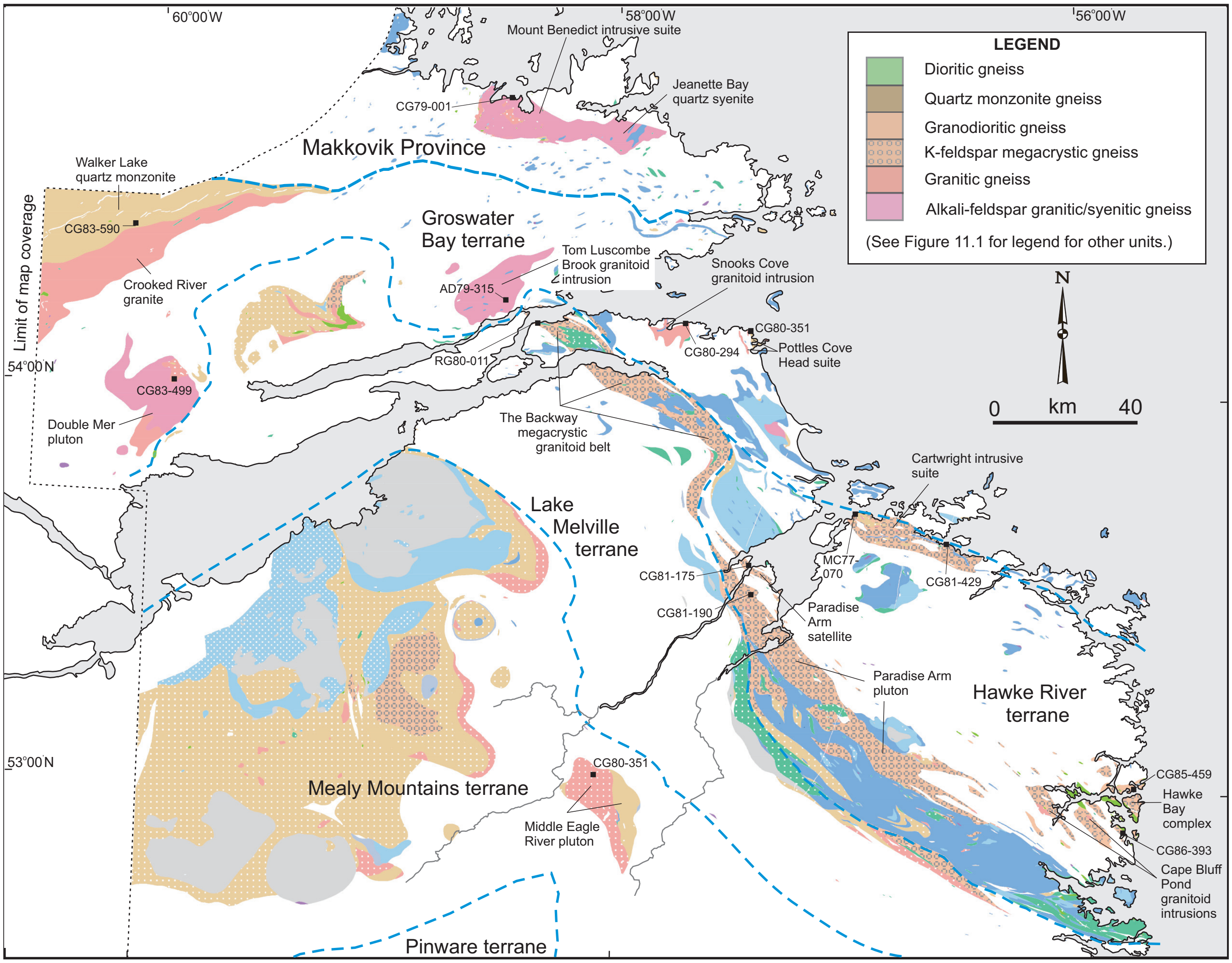


Figure 12.1. *Late Labradorian granitoid rocks not addressed in previous chapter (named units).*

this area, so the unit's exact extent remains somewhat uncertain. A sample from the district (CG79-444; Appendix 2, Slab images 12.1) is a distinctive diorite to monzodiorite that contrasts from the prevalent syenitic rocks elsewhere in the intrusion. Placer Development Limited (Burns, 1979; Davidson and Kowalczyk, 1979) mapped gabbro and diorite in the same area and up to 1 km farther east (JB78-048b, JB78-048c, DD79-C160), which is shown as Unit P_{3C}dr on Gower's (2010a) Benedict Mountains map region. The area of diorite depicted is much smaller than Kerr's Unit 26 and further mapping is needed to reconcile the discrepancy between the two.

Kerr (1994) describes the unit as plagioclase–porphyritic gabbro, leucogabbro and diorite, locally transitional into monzonite, noting that plagioclase alignment and oikocrystic habits of mafic minerals indicate a cumulate origin.

In thin section, Kerr (1994) recorded the rocks as consisting of quartz (up to 2%), plagioclase (50–80%), microcline (5–20%), purple/brown tianaugite and pleochroic hypersthene (5–20%), and relict olivine (up to 10%). Red-brown biotite, apatite, opaque oxide(s) and secondary hornblende, actinolite, epidote and titanite may also be present.

12.1.1.2 Monzonite, Syenomonzonite and Syenite (P_{3C}mz, P_{3C}yq)

This group of rocks comprises most of the Mount Benedict Intrusive Suite. The rocks weather to shades of buff, grey, pink and white, are massive or weakly foliated, homogeneous and medium or coarse grained (Plate 12.1A). They are commonly plagioclase-porphyritic, although, typically, the contrast between phenocrysts and matrix is not great. This leads to a characteristic 'speckled-eggshell' texture (Gower, 1981), due to larger-than-groundmass (gener-

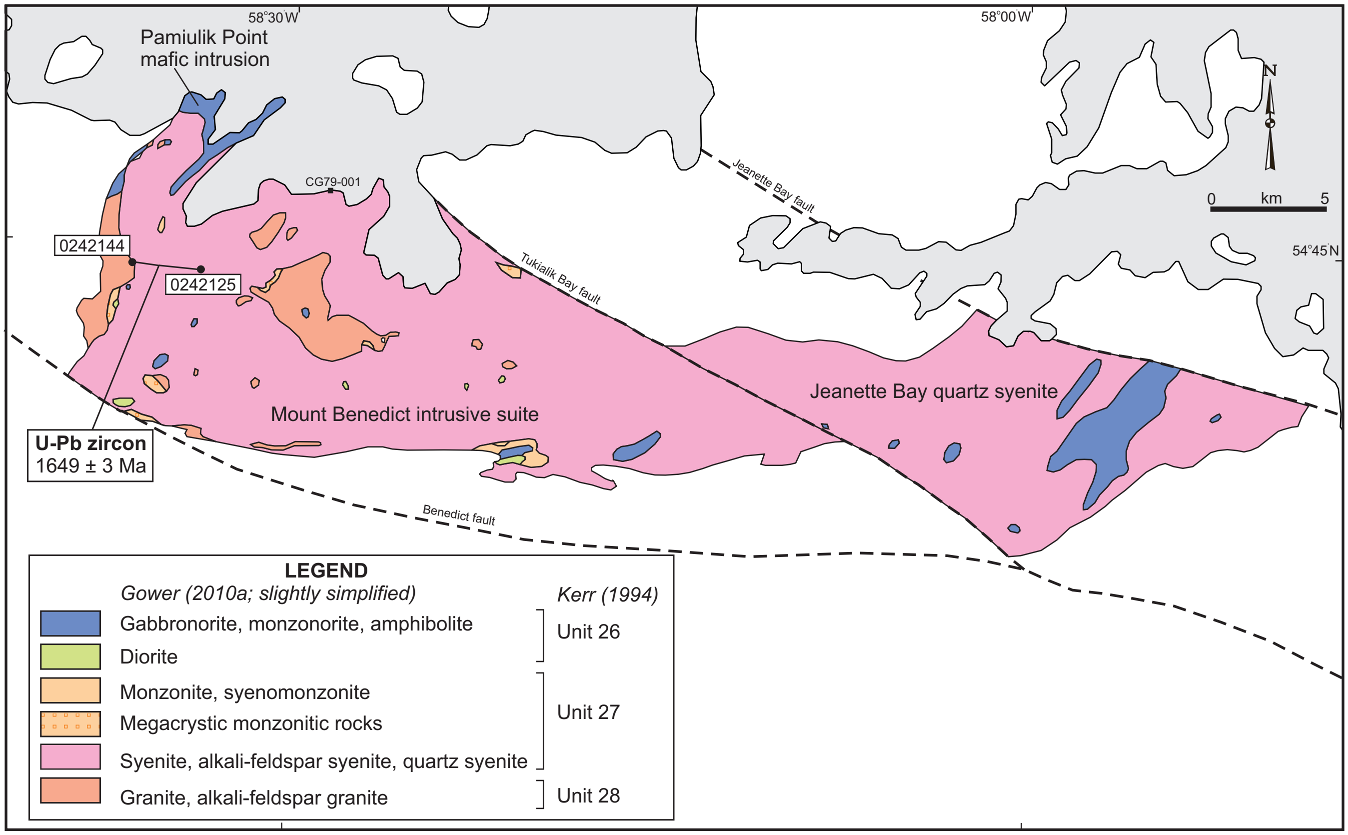


Figure 12.2. *Mount Benedict Intrusive Suite and Jeanette Bay quartz syenite. The spatially related Pamiulik Point mafic intrusion was addressed in the previous chapter.*

ally 0.5–1.0 cm) plagioclase crystals in a finer grained, equigranular matrix (0.2–0.5 cm) of K-feldspar, mafic minerals, and minor quartz (Appendix 2, Slab 12.1). From stained slabs, it is seen that K-feldspar tends to be appreciably more abundant than plagioclase, hence a syenite label (rather than monzonite) is generally to be preferred. A lithological variant is a distinctive monzonite containing euhedral plagioclase phenocrysts around 2 cm long in a matrix of K-feldspar and mafic minerals (Appendix 2, Slab 12.1). This rock was found sporadically along the western margin of the unit, and a similar rock is present in the easternmost part.

All thin sections of the Mount Benedict Intrusive Suite in the author's collection are from this unit (AD79-283, CG79-001A, CG79-013B, CG79-257, CG79-433, CG79-436, CG79-459, CG79-464, CG79-469, CG79-517, CG79-699, SG68-129, SG68-220, SGJ68-170.1, SGJ68-170.2). Igneous textures are well preserved. Plagioclase is anhedral to subhedral, moderately to strongly zoned, has sodic rims and is commonly severely sericitized. Gower (1981) noted that plagioclase shows corroded outlines and suggested that the plagioclase phenocrysts have been partially resorbed by the magma. Most of the K-feldspar is microcline, but flame perthite is also present. In some samples, K-feldspar mantles plagioclase, giving a pseudo-rapakivi appearance. Quartz is interstitial or forms a granophyric intergrowth with groundmass K-feldspar. It rarely exceeds 10% of the rock (*i.e.*, the rock is not quartz syenite). Mafic minerals are green-brown to blue-green hornblende, buff-orange biotite, and, in four thin sections, relict clinopyroxene occurs in cores of hornblende grains (CG79-013B, CG79-433, CG79-436, SG68-129). Hornblende–quartz symplectite is interpreted to have been derived from the breakdown of clinopyroxene (Photomicrograph, 12.1A). Accessory minerals are an opaque oxide, apatite, titanite (mantling the opaque oxide), zircon, allanite, fluorite and secondary white mica, chlorite and epidote/clinozoisite. Fluorite is present in three samples (CG79-464, SG68-129, SG68-220). Fluorite was also recorded in outcrop at CG79-100, CG79-104 and SGJ68-170. The localities are widely scattered.

12.1.1.3 Syenite, Quartz Syenite and Granite (P_{3C}ga)

Apart from composition, Kerr's units 27 and 28 are distinguished by grain size, being medium to coarse grained, and fine to medium grained, respectively. Kerr's fine- to medium-grained Unit 28 correlates with Gower's (1981) fine- to medium-grained syenitic variant found at higher elevations on Mount Benedict and neighbouring peaks. On Gower's (2010a) Benedict Mountains map region these rocks have been separately depicted as Unit P_{3C}ga, *vs.* the syenitic rocks (P_{3C}yq) that surround them. Discrimina-tion between the two units is based on a combination of Gower's original field data plus detailed mapping in the area by

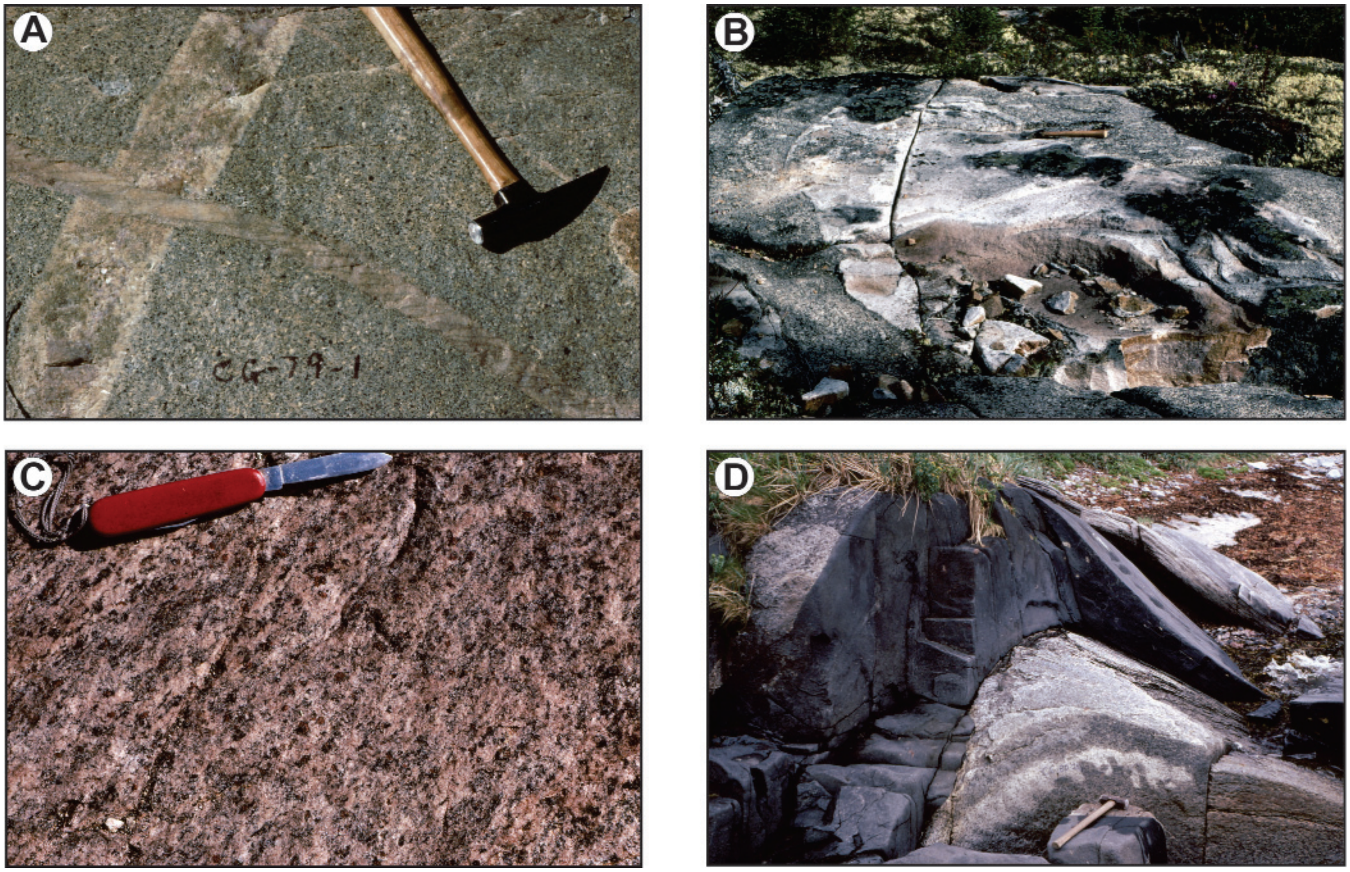


Plate 12.1. *Examples of late-Labradorian granitoid intrusions in the Cape Harrison domain (Makkovik Province) and Groswater Bay terrane. A. Mount Benedict quartz syenite, intruded by minor granitoid dyke and quartz vein (CG79-001), B. Walker Lake quartz monzonite hosting enclaves of fine-grained granite (Crooked River type) (CG83-590), C. Tom Luscombe Brook garnetiferous quartz syenite/alkali-feldspar granite (AD79-315), D. Snooks Cove granite hosting metamorphosed and folded mafic dyke (CG80-294).*

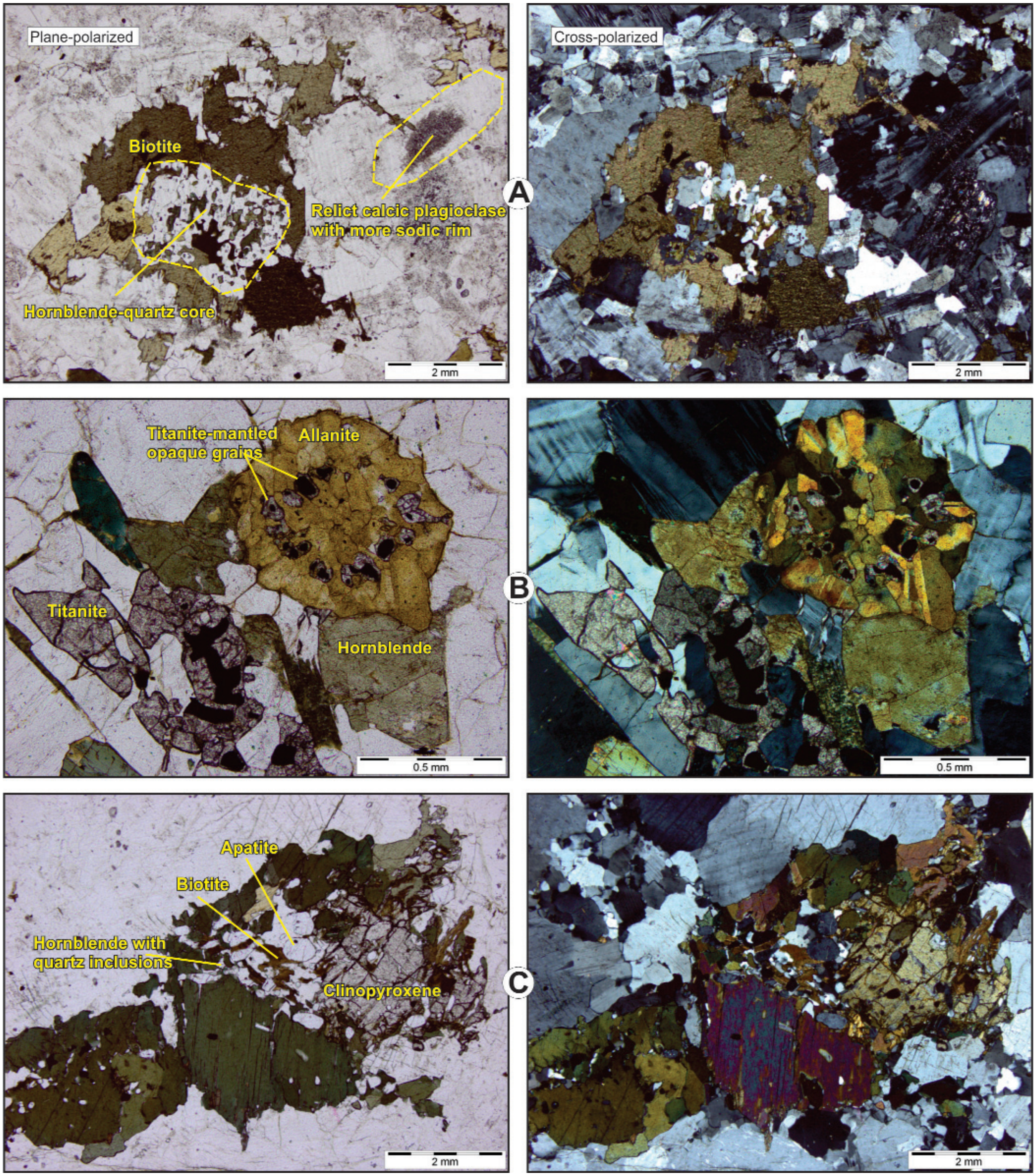
Placer Development Limited (Davidson and Kowalczyk, 1979). Kerr's Unit 28 covers a larger area, thus reconciliation between Gower's and Kerr's mapping is still required.

The unit is best described by Kerr (1989a, 1994). It is pink-, grey- or buff-weathering, homogeneous, fine to medium grained and locally porphyritic. K-feldspar is a common phenocrystic phase, but vestigial plagioclase phenocrysts and speckled-eggshell texture are present locally. The unit grades into a feldspar or quartz-feldspar porphyry of subvolcanic aspect, suggesting a high level of emplacement. The observation of Gower (1981) that the unit is found at higher elevations is echoed by Kerr (1989a, 1994). Gower suggested that it might represent a roof facies, whereas Kerr thought that it could represent the uppermost part of a compositionally layered body (not incompatible options).

As described by Kerr (1994), the unit contains 5 to 15% quartz, 50 to 80% K-feldspar, 10 to 35% sodic plagioclase, up to 5% biotite and hornblende (biotite dominant), and accessory titanite, zircon, allanite and fluorite (which means the rocks are syenite and quartz syenite, rather than granite – Gower's P_{3C}ga unit embeds this latitude). Graphic quartz–microcline intergrowth textures dominate the groundmass and K-feldspar phenocrysts comprise coarse perthite. Rare plagioclase phenocrysts are embayed and corroded.

12.1.1.4 Other Rock Types

In addition to units P_{3C}yq and P_{3C}ga, several other subsidiary rock types are depicted on Gower's (2010a) Benedict Mountains map region, especially adjacent to the western and southern borders of the Mount Benedict Intrusive Suite. These include granite (P_{3C}gr), porphyritic granite (P_{3C}gp), monzonite (P_{3C}mz), monzonorite (P_{3C}mn) and diorite (P_{3C}dr). Almost all of these additions, relative to Gower's (1981) map, are based on field observations recorded by Placer Development Limited geologists (Burns, 1979; Davidson and Kowalczyk, 1979). Other features of the Mount Benedict Intrusive Suite, common to all units are: i) sparse enclaves of mafic rocks (diorite to gabbro), ii) east-trending mafic dykes, and iii) very rare pegmatites. Some



Photomicrograph 12.1. *Some features of late Labradorian granitoid rocks. A. Mount Benedict Intrusive Suite monzonite/syenite showing disequilibrium features. 1. Hornblende–quartz core (after clinopyroxene), surrounded by biotite. 2. Calcic plagioclase core with more sodic rim (CG79-001A), B. Double Mer pluton showing titanite-mantled opaque grains forming a ring within recrystallized allanite (CG83-499), C. Cartwright intrusive suite granite showing relict clinopyroxene evolving to hornblende + quartz (cf. photomicrograph 12.1A) (MC77-070A).*

larger masses of mafic rock have been mapped in the poorly known eastern part of the unit and are considered by the author to be rafts, but understanding of them is meagre. They could be included as part of Kerr's Unit 26.

12.1.2 JEANETTE BAY QUARTZ SYENITE (P_{3C}yq)

The Jeanette Bay quartz syenite was defined as a geological unit by Gower (1981, his Unit 22) and named by Kerr (1989a, 1994). It is a pink-weathering, coarse-grained, quartz syenite to granite. Gower (1981, page 17) considered that it was 'probably closely related to Unit 21' (Mount Benedict Intrusive Suite). This stance was based on spatial juxtaposition and field comparison. From Figure 12.2, it would seem that the Jeanette Bay quartz syenite is no more than a fault-offset segment of the Mount Benedict Intrusive Suite, but that oversimplifies matters. The Jeanette Bay quartz syenite has similar, but not identical textural features. Kerr (1989a, 1994) also noted that the Jeanette Bay quartz syenite appears to be more recrystallized and is geochemically distinct. He refrained from classifying it as either Makkovikian or Labradorian. Despite the unit being designated as P_{3C}yq on Gower's (2010a) Benedict Mountains and Byron Bay map regions, Kerr's position remains viable.

Two thin sections are available in the author's collection (CG79-519, DB79-206). The both have anhedral plagioclase, K-feldspar (microcline and perthite), quartz, orange-green biotite, blue-green amphibole (in DB79-206), and opaque oxide, apatite, titanite, allanite and secondary white mica, chlorite and epidote.

12.1.3 WALKER LAKE QUARTZ MONZONITE (P_{3C}mq)

The Walker Lake quartz monzonite (Figure 12.1) is the name used here and by Gower (1984, 1986) for part of a granitoid unit that continues west and north of the region addressed in this report. Including those parts outside of the boundaries of this report, the Otter Lake–Walker Lake granite has a total length of about 120 km and a maximum width approaching 40 km. The entire body was named the Otter Lake–Walker Lake granite by Ryan (1982). As explained by Ryan (1984), this composite name came about because no demarcation line could be drawn between what Brinex geologists and Smyth (1977) referred to as Walker Lake granite, and what Ryan and Harris (1978) termed Otter Lake granite. Ryan (1984) also coined the name Nipishish Lake Intrusive Suite, which embraces both the Otter Lake–Walker Lake granite and the Crooked River granite (next section). In turn, the Nipishish Lake Intrusive Suite is part of the Trans-Labrador batholith, which extends across most of Labrador very slightly oblique to the Grenville front. Description of the Otter Lake–Walker Lake granite in areas north of those addressed in this report is given by Kerr *et al.* (1992) and Kerr (1994), including mention of relationships with the adjacent, and coeval, Witchdoctor Lake and Burnt Lake granites.

Within the area addressed in this report, the Walker Lake granitoid rock is mostly quartz monzonite, hence modification of the name from granite used farther west. In the part mapped by Gower (1984, 1986), the rock is a pale-pink, white- or creamy-weathering, coarse-grained quartz monzonite, with compositional variations that include monzonite, monzodiorite and granite. Gower (1986) interpreted the monzodiorite and granite as differentiated products of a parent magma that mostly crystallized as quartz monzonite. The granitoid rocks are dominantly massive, but foliated varieties occur locally, especially in southern outcrops. A seriate to locally K-feldspar megacrystic texture is commonly developed. Mafic enclaves are rare and found mostly within monzodiorite. The lack of enclaves is in contrast to other parts of the Otter Lake–Walker Lake granite, but it remains unknown whether this is due to a genuine difference in enclave abundance, or less-detailed observation by the present author, or because separate intrusions have been mapped. Minor intrusions include buff-pink aplite and microgranite and rare pegmatite.

A thorough summary of K–Ar and Rb–Sr geochronological data for the Otter Lake–Walker Lake granite from sites west of the area addressed in this report has been provided by Ryan (1984). The data, collectively, imply an age between *ca.* 1650 and 1500 Ma. Two U–Pb zircon ages have since been obtained, also from sites outside of the region addressed in this report. Kerr *et al.* (1992; sample AKZ-8) reported an age of 1647 ± 2 Ma, based on two zircon fractions, one concordant and one 1.2% discordant. Brooks (1983; sample CBL-109) had earlier obtained an age of 1628 ± 9 Ma, based on three zircon fractions, but as the zircons were unabraded and the data discordant, the more recent 1647 Ma age is to be preferred. Sm–Nd whole-rock data for sample AKZ-8 (recalculated from Kerr and Fryer, 1994), are T_{DM} = 2021 Ma and εNd (1.647 Ga) = –1.03.

Of the 13 thin sections prepared in this study, one was termed monzodiorite (CG83-110), three termed monzonite (CG83-433, CG83-456, CG83-502A), seven termed quartz monzonite (CG83-111, CG83-505, CG83-508, CG83-518, CG83-525, CG83-536, CG83-537), and two termed granite (CG83-512, CG83-529). Common to all samples are plagioclase, K-feldspar, quartz and biotite. All felsic minerals form large relict primary grains surrounded by recrystallized aggregates. In some samples, plagioclase shows normal and oscillatory zoning, emphasized by secondary clinozoisite or white mica. Primary K-feldspar occurs as stringlet perthite, but large areas are now microcline, as is all recrystallized groundmass K-feldspar. Aggregates of biotite, epidote, titanite, and opaque minerals have replaced amphibole, although blue-green relict hornblende remains in CG83-456, CG83-518 and CG83-525. Biotite (olive-green), titanite and opaque oxides also occur as primary phases. Apatite, allanite (cores to epidote) and zircon are characteristic accessory minerals. Secondary chlorite (from biotite) and white mica (from biotite and

K-feldspar) are widespread. Garnet was found in two thin sections (CG83-536, CG83-537). In samples from farther west, Ryan (1984) mentioned clinopyroxene as an additional minor phase as relict cores within amphibole; none was seen in the author's samples, however. Kontak (1980) attributed alteration of feldspars and mafic silicates in the Walker Lake granite to deuteric processes, but the extensive recrystallization seen in some samples, coupled with penetrative foliation and minor garnet were interpreted by Gower (1986) and Gower and Erdmer (1988) to be due to regional greenschist- to lower amphibolite-facies metamorphism.

12.1.4 CROOKED RIVER GRANITE (P_{3C}gr)

The Crooked River granite (Figure 12.1) is a biotite- and muscovite-bearing leucogranite grouped by Ryan (1984) with the Otter Lake–Walker Lake granite as the Nipishish Lake Intrusive Suite. The areas underlain by Crooked River granite were previously mapped by Piche (1957) and Williams (1970) in NTS 1:250 000 sheet 13K, and by Stevenson (1970) in 13J. Piche referred to the rocks as granitized sediments, and Williams and Stevenson both described them as biotite–quartz paragneiss (as tended to be the interpretation at the time for well-banded quartzofeldspathic gneiss). Ryan (1980, 1984) challenged then-prevailing dogma, pointing out that no evidence of metasedimentary origin was observed and the presence of gneiss inclusions in granite indicated an intrusive origin. Ryan conceded, however, that the rocks' saccharoidal texture strongly resembles recrystallized rhyolite of the Sylvia Lake Formation (Bruce River Group). The name Crooked River granite was first used by Ryan (1982), although the rock to which the name applies was described earlier by Ryan and Harris (1978) and Ryan (1980).

The Crooked River granite described herein is situated in NTS areas 13K07, 13K08, 13J05 and 13J06. Mapping of these areas at 1:100 000 scale was carried out by Gower (1984, 1986). Correlation of the granite between the regions mapped by Ryan (*e.g.*, 1982) and Gower can be made without difficulty as the unit is distinctive. Within the area mapped by Gower (east of longitude 60°30'W), the Crooked Lake granite is about 80 km long, tapering out eastward from a maximum width of 13 km wide. West of longitude 60°30'W, it has been mapped by Ryan for an additional 40 km along strike, expanding to 36 km in width, although interleaved with Walker Lake granite.

The rocks are buff- to pale-pink-weathering, massive to foliated, and have a sugary texture. They may be termed aplite, microgranite, or fine- to medium-grained granite. Locally, the rocks are deformed to muscovite schist. As evidence of plutonic origin, Gower (1986) cited intrusive contacts with other granitoid units, homogeneity over wide areas, and lack of bedding. Quartz veins, hematized fractures, and rarity of mafic enclaves are characteristic of the unit.

Some relative and absolute age data are available. At data station CG83-001, Crooked River granite is exposed with hornblende-bearing gneissic granodiorite like that found in the Groswater Bay terrane. Contact relationships are not clear, but the granite lacks the deformational and metamorphic history preserved in the gneissic granodiorite, and is therefore inferred to be younger. Ryan (1984) reported that the Crooked River granite intrudes the Sylvia Lake Formation and the Walker Lake granite. The pink-buff aplite and microgranite mentioned above as intruding the Walker Lake quartz monzonite might belong to the Crooked River granite, although Gower (1986) interpreted fine-grained granite within monzodiorite as possible enclaves of Crooked River granite within the Walker Lake granite (Plate 12.1B). This outcrop (CG83-590) needs to be re-examined to confirm (or otherwise) the validity of this conclusion, in the light of other field relationships and more recent geochronological information that could suggest the reverse. A rhyolitic ignimbrite from the Sylvia Lake Formation has a U–Pb age of 1649 ± 1 Ma (Schärer *et al.* (1988) and the Walker Lake granite an age of 1647 ± 2 Ma (Kerr *et al.*, 1992). Ryan (1984) provided whole-rock geochemical data showing that the Crooked River granite and Walker Lake granite are chemically similar to rhyolitic and andesitic/trachytic rocks of the Sylvia Lake Formation, respectively. Collectively, roughly coeval emplacement of all three units is implied, so it should be kept in mind that contradictory field observations do not mean some are necessarily erroneous.

The mineral assemblage (thin sections CG83-122, CG83-225, CG83-227, CG83-541, CG83-542, CG83-549, CG83-560, CG83-561, CG83-585) comprises plagioclase, microcline, quartz, olive-green to green-buff biotite, muscovite, an opaque oxide, apatite, titanite, ± zircon, allanite, clinozoisite/epidote, fluorite (CG83-225, CG83-542), and minor secondary chlorite. Small garnets were seen in CG83-542 and CG83-585, and blue-green amphibole in CG83-227. Sample CG83-542 is muscovite schist and, rather than having a granite protolith, it might well be a metasediment like that found nearby in the Groswater Bay terrane. Three other rocks from within the Crooked Lake granite were examined in thin section. One is a metagabbro, which is correlated with the Adlavik-type mafic rocks (CG83-544), and the other two are monzodiorite and diorite (CG83-579, CG83-580, respectively), which are interpreted as enclaves within the granite.

12.2 GROSWATER BAY TERRANE

12.2.1 DOUBLE MER PLUTON (P_{3C}yq, P_{3C}ga, P_{3C}mq)

The Double Mer pluton is situated in the Groswater Bay terrane, northwest of Lake Melville. It is roughly circular in plan view and is 25 km in diameter. Its shape is irregular in detail, having a sigmoidal S form with tails extending to the north-northeast and south-southwest (Figures 12.1 and 12.3). The pluton was first distinguished as a granitoid unit (distinct from the surrounding quartzofeldspathic gneiss), by

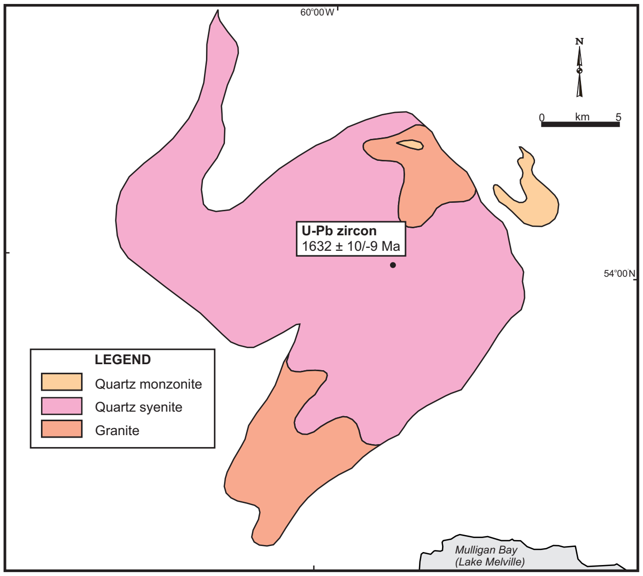


Figure 12.3. *Double Mer pluton.*

Eade (1962) in NTS map area 13G, and subsequently by Stevenson (1967a, 1970) in 13F and 13J, respectively. It was not identified by Williams (1970) during his 1:250 000-scale mapping in 13K. The extent of the unit was refined during 1:100 000-scale mapping in 13J and 13K by Gower (1984, 1986) and in 13F and 13G by Erdmer (1983, 1984). The pluton was first termed Double Mer granite in an unpublished geochronology report by Krogh (1983), and the name was adopted by Schärer *et al.* (1986). The name was not used by Gower or Erdmer, although the unit was separately described. The modification of the name to Double Mer pluton here is a tacit acknowledgment that the unit is not solely, or even dominantly, granite.

The unpublished preliminary age obtained by Krogh (1983) was slightly refined by Schärer *et al.* (1986) who reported a discordant upper intercept age of 1632 +10/–9 Ma and a lower intercept age of 941 +39/–36 Ma, based on four multigrain zircon fractions (sample CG84-471). The upper intercept was interpreted to date the time of zircon crystallization, and the lower intercept attributed to episodic Pb loss (during late/post-Grenvillian times). Rb–Sr and Sm–Nd whole-rock data for the same sample, reported by Schärer (1991), are $I_{Sr(t)}$ = 0.70308, T_{DM} = 1906 Ma and εNd (1.632 Ga) = +0.26. The values shown by Gower (2010a: Double Mer map region) are slightly different due to the calculation approach used.

As currently depicted on 1:100 000-scale maps, most of the pluton is mapped as quartz syenite, with granite in the southwest and northeast, and quartz monzonite in a satellite stock east of the main pluton. The rocks are pink-, buff-, orange-pink- or brick-red-weathering, mostly coarse grained (but recrystallized to medium grained), and massive to strongly foliated. For the most part, the rocks are homogeneous, but develop an indistinct gneissosity in border areas, and, locally, appear to be interleaved with the surrounding gneiss. Gower (1986) noted that the rocks grade into quartz monzonite and muscovite granite on the west and north margins of the body, respectively. The rocks lack mafic enclaves or minor granitoid intrusions.

A large selection of thin sections is available (CG83-474A, CG83-492, CG83-494, CG83-496*, CG83-497A, CG83-499, CG83-500, CG83-607, CG83-608, CG83-620, CG83-621, MW82-117, MW82-120, MW82-121, PE82-049, PE82-050A, PE82-051,PE82-052, PE82-069A, PE82-071, PE82-073, PE82-074, PE82-098B*, PE82-099, PE82-101, PE82-107, PE82-243, SGJ68-302). [The asterisks indicate samples for which mineral analytical data are available.] All samples contain plagioclase (An_{20} or less – Erdmer, 1984), K-feldspar (microcline or perthite), quartz (all felsic minerals polygonized), olive-green to dark orange-brown biotite, dark blue-green (sodic) amphibole (except PE82-071, PE82-074, PE82-243), an opaque oxide, apatite, and zircon (rounded cores, euhedral overgrowths). Almost half the thin sections contain green clinopyroxene (alkalic?), and nearly three-quarters of them have garnet. A few (10%) have weakly pleochroic orthopyroxene. Clinopyroxene, orthopyroxene and garnet are all relict minerals and have been replaced by amphibolite, plagioclase, biotite, titanite and opaque minerals in various combinations. About two-thirds of the samples contain allanite, in some cases as abnormally large, zoned grains. Almost half contain titanite, commonly mantling the opaque mineral. A thought-deserving example of allanite-titanite-opaque mineral interaction is displayed in Photomicrograph 12.1B, which shows a ring of titanite-mantled opaque inclusions within allanite. Scapolite and epidote are present in CG83-608, and minor epidote is also present in CG83-474A and PE82-050A. These samples are close to the border of the pluton and may be the product of contamination from the surrounding more Ca-rich gneisses. The samples from the granite in the southwest part of the body are somewhat different from the remainder of the body, and require further investigation to determine whether they should be included as part of it. Mineral analyses for biotite, garnet and clinopyroxene from samples CG83-496 and PE98-098B were reported by Gower (1986) and Erdmer (1984), respectively.

12.2.2 TOM LUSCOMBE BROOK GRANITOID INTRUSION (P_{3C}yq/P_{3C}gr)

This unit forms a northeast-trending ovoid body measuring 32 by 12 km in the southern part of the Groswater Bay terrane, north of Rigolet (Figure 12.1). A small satellite body to the northwest of the main intrusion has also been included. The area was mapped at 1:250 000 scale by Stevenson (1970), and at 1:100 000 scale by Gower *et al.* (1981). The body was not distinguished from the surrounding gneiss by Stevenson and the first depiction of the unit as a discrete intrusion was by Gower *et al.* (1981). It should be kept in mind that no further mapping of the body has been carried out since 1979–1980, when the mappers were still unfamiliar with the rocks in the region. Thus, despite some follow-up study of samples collected, there is much scope for reinterpretation of these rocks. For convenience, the body is named here, but it is uncertain whether or not this is really justified. No geochronological data are available.

The rocks are pink-weathering, medium to coarse grained, and massive to nebulitic or schlieric. Compositions include syenite, quartz syenite, alkali-feldspar syenite and granite (Plate 12.1C). A few rocks were termed monzonite or granodiorite in field notes. Garnet was recorded at most outcrops, locally over 0.5 cm in diameter. One outcrop was noted as having K-feldspar megacrysts. Some stained slabs are texturally distinct in having plagioclase, up to 1 cm in diameter, set in a medium-grained matrix composed of K-feldspar, minor quartz and mafic minerals. Amphibolite was seen at a few outcrops and a biotite-rich, garnet-bearing diabase dyke recorded at RG80-312. No minor granitic intrusions were recorded in field notes.

Thin sections show that most of the rocks from the body are syenitic (AD79-278, AD79-316, AD79-318A, CG79-659, CG79-661, CG79-672, CG80-401, CG80-403, CG80-566, CG80-583, SG68-009, SG68-011), consisting of plagioclase, microcline or perthitic K-feldspar, quartz, olive-green to orange-brown biotite, blue-green amphibole, pale-green clinopyroxene, garnet, an opaque oxide and apatite. Late-stage or secondary minerals are titanite (mantling opaque oxide), chlorite, epidote and white mica. Sample CG80-583 is distinct in lacking quartz, biotite and amphibole. The phases present do not represent an equilibrium assemblage, except for AD79-318A and CG79-672, which both lack amphibole and are granoblastic garnet-pyroxene granulite (AD79-318A also contains orthopyroxene). In the other samples, it is clear that both clinopyroxene and garnet are relict representatives of that high-grade metamorphic assemblage. The clinopyroxene contains abundant small opaque-mineral inclusions and is replaced by amphibole and biotite. The garnet has amoeboid, residual form, having been largely replaced by plagioclase, biotite and opaque minerals (ghost garnet). Note that similar retrograde features are present in some of the Pottles Cove Head suite samples (Section 12.2.4).

Two petrographic exceptions are samples CG80-411 and SG68-067B. Sample CG80-411 is a granodiorite, characterized by biotite and amphibole as mafic minerals and large allanite grains mantled by epidote; no clinopyroxene or garnet are present. The sample is at variance with field notes, which describe the outcrop as syenitic. There is no field mention that the rock might be an erratic or a xenolith, or any indication that there might have been a sample-labelling error, so why it is there remains unexplained. Sample SG68-067B is clinopyroxene- and garnet-bearing amphibolite. Similarly to the syenite, clinopyroxene and garnet are relicts from a former granulite-facies metamorphic assemblage. In particular, the garnet is mostly replaced by plagioclase and biotite.

12.2.3 SNOOKS COVE GRANITOID INTRUSION ($P_{3C}gr/P_{3C}yq$)

The Snooks Cove granitoid intrusion (Figure 12.4) is located in the Groswater Bay terrane on the south side of Groswater Bay between 36 and 46 km east of Rigolet. The rocks were mapped by Gower *et al.* (1981), but the name is newly introduced here.

The defining characteristics of the unit are that it is pink-weathering, coarse grained (recrystallized to medium grained), overall homogeneous, and generally strongly foliated (but not a banded gneiss) and, commonly, also strongly lineated. The rocks were termed granite to granodiorite in the field, but, based on stained slabs and thin sections, the label 'granite to quartz syenite' is more appropriate. The rocks have discontinuous, vague, minor leucosome segregations and, rarely, show hints of a former K-feldspar megacrystic aspect, but this may simply be due to deformation of a formerly coarse-grained rock. A near ubiquitous feature is the presence of metamorphosed, commonly garnet-bearing, metamorphosed mafic dykes (Plate 12.1D). Several outcrops show two generations of crosscutting, termed in field notes as 'early black dykes' and 'later brown dykes', but this classification fails at one outcrop (CG80-304), which has three generations of dykes. The granite and mafic dykes are sparsely intruded by pegmatitic veinlets.

A sample of pink granite from data station CG80-304 was included in a Rb–Sr whole-rock isotopic investigation by Brooks (1982b; his sample CBL 324). A range of granitoid rocks (subdivided into nebulitic and homogeneous granitoid rocks at the time) were collected from various sites along the eastern part of the southern shore of Groswater Bay. All 13 samples were included on a single pooled regression and yielded an errorchron regression of 1629 ± 68 Ma, I_{Sr} = 0.70287, considered to date the time of metamorphism. It was a useful result when obtained, but has an obvious shortcoming in making the assumption that the various samples are all co-genetic. Gower (2010a; Groswater Bay map region) calculated that the CG80-304 sample has $I_{Sr(t)}$ = 0.70136, adopting a crystallization age of 1650 Ma. Essentially, the rock remains undated and its designation as

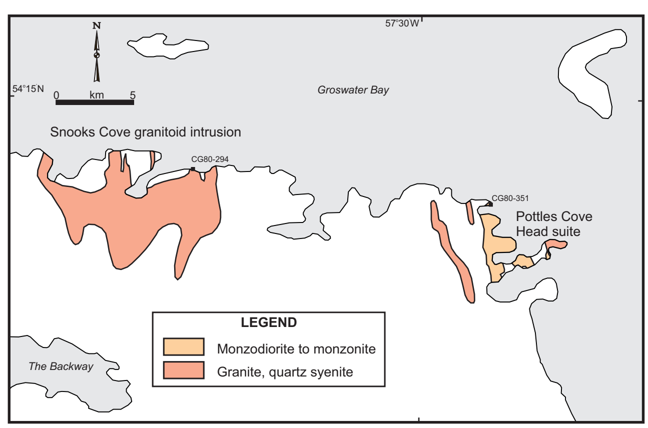


Figure 12.4. *Snooks Cove granitoid intrusion and Pottles Cove Head suite.*

a P_{3C} mid- to late-Labradorian intrusion rests, rather tenuously, on its lack of migmatization, in contrast to the gneisses that envelop it.

The mineral assemblage seen in thin section (CG80-246, CG80-255, CG80-269, CG80-304A, SG68-112) is plagioclase, microcline, quartz (not in CG80-269), olive-green to buff biotite, blue-green amphibole (CG80-246, CG80-255), clinopyroxene (only in CG80-269), an opaque oxide, sulphide (not in CG80-246, CG80-255), apatite, titanite (mantling the opaque phase in part) and sporadic zircon and allanite.

12.2.4 POTTLES COVE HEAD SUITE (P_{3C}mz, P_{3C}gr)

Rocks titled the Pottles Cove Head suite are located in the Groswater Bay terrane on the southern shore of Groswater Bay at its extreme eastern end (Figures 12.1 and 12.4). The rocks form a cluster of small bodies and their viability as a discrete entity is by no means certain, being based mostly on being more homogeneous than the enveloping quartzofeldspathic gneiss. The name is newly introduced here, but further investigation is required to establish whether recognition of a separate unit is valid.

As mapped, the suite comprises a 7-km-long, 3-km-wide, north-trending core of monzodiorite to monzonite, flanked by smaller satellite bodies of granite. The core monzodiorite is brown- or honey-weathering, medium to coarse grained, homogeneous and weakly to strongly foliated and lineated. It is not gneissic. Both mafic enclaves (locally forming agmatized mafic layers) and garnet-bearing metamorphosed mafic dykes were recorded, but neither is particularly abundant. Minor granitic intrusions are also rare. Apart from pink-weathering, compositional difference and rare diffuse leucosome, the granite is similar to the monzodiorite. It seems to host more metamorphosed mafic dykes, some of which are tightly folded and boudinaged (Plate 12.2A).

Two samples from the monzodiorite subunit (CG80-355, CG80-379 – both monzonite) and two from the granite subunit (CG80-329,

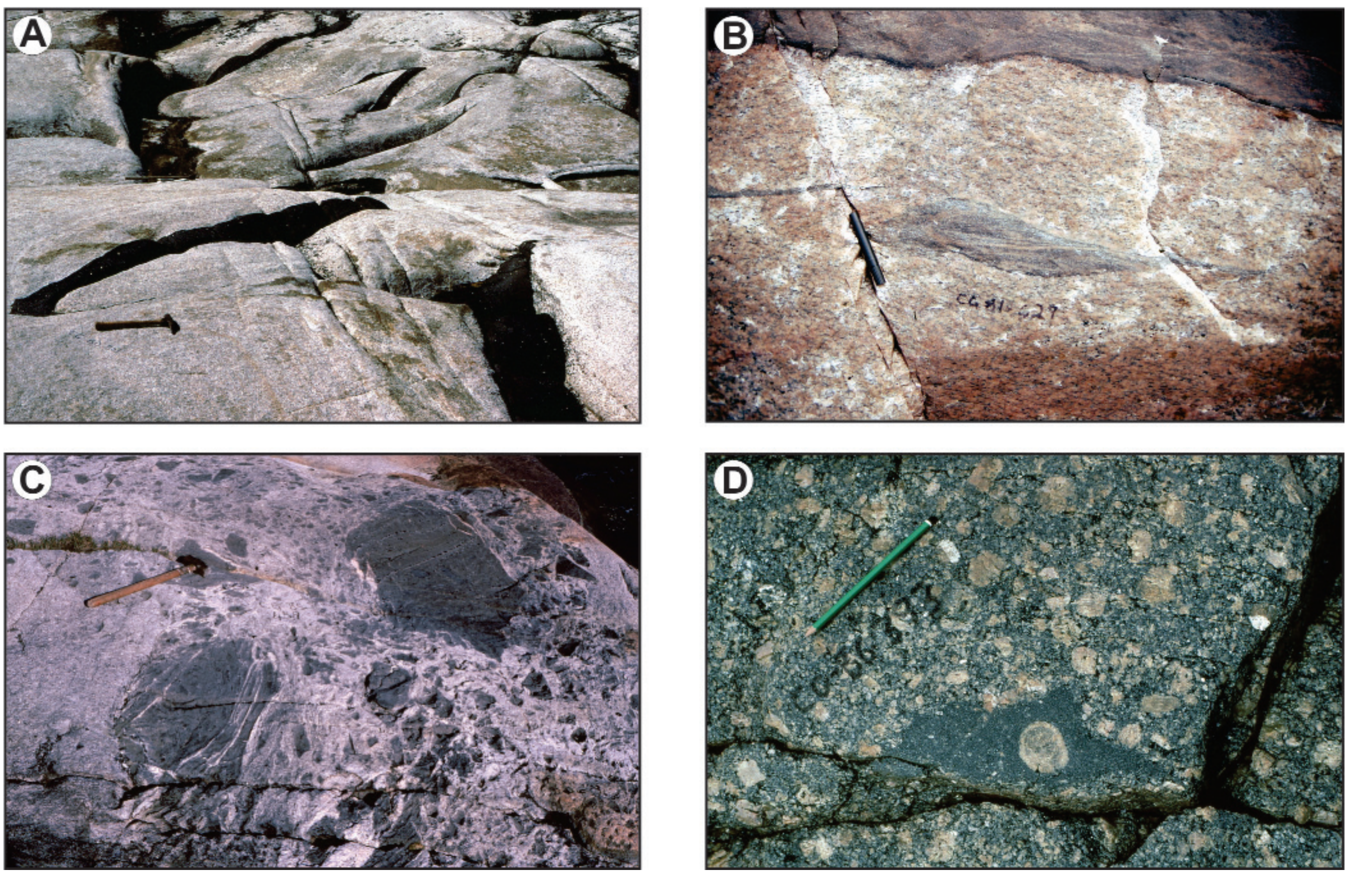


Plate 12.2. *Examples of late-Labradorian granitoid intrusions in the Groswater Bay and Hawke River terranes. A. Pottles Cove Head granite with disrupted mafic dyke (CG80-351), B. Cartwright intrusive suite granite hosting enclaves of gneiss. Granite from this site has an age of 1645 + 7/–5 Ma (CG81-429), C. Hawke River complex showing example of granitoid rock containing variety of mafic enclaves (CG85-459), D. Cape Bluff Pond K-feldspar megacrystic granitoid rock containing mafic enclave, which also has K-feldspar megacryst (CG86-393).*

CG80-351 – quartz syenite and alkali-feldspar granite, respectively) were examined petrographically. The mineral assemblage is mostly the same in both groups, namely plagioclase, K-feldspar (microcline and perthite), quartz, orange-brown biotite, amphibole, clinopyroxene, garnet, an opaque oxide and apatite (plus sporadic other accessory phases). Key petrographic features are that: i) clinopyroxene is residual, having been extensively replaced by amphibolite sieved with abundant quartz inclusions, and ii) garnet has been largely (or totally in some cases) replaced by plagioclase and biotite ± amphibole, in, what appears to be, a typical decompression texture. Sample CG80-351 lacks amphibole, garnet and an opaque phase, and is clearly somewhat distinct. This locality coincides with one of Stevenson's 1968 sites (SGJ68-052) where field notes make the comment that this is the "most acid rock found so far".

12.3 HAWKE RIVER TERRANE

12.3.1 CARTWRIGHT INTRUSIVE SUITE (P_{3C}gp, P_{3C}mq)

12.3.1.1 Description and Age

During 1:100 000-scale mapping in the Cartwright area, rocks now grouped as the Cartwright intrusive suite (Figure 12.5) were traced as an 8-km-wide zone for 40 km southeast from Cartwright (Gower *et al.*, 1982b). The northern side of the body marks the boundary between the Groswater Bay terrane to the north and the Hawke River terrane to the south.

Recognition (in the vicinity of Cartwright) of this separately mappable granitoid unit was first made by Cherry (1978a, b) who divided it into two subgroups, namely monzonite, and granite to augen gneiss. Gower *et al.* (1982b) defined two similar subunits, namely: i) monzonite, and ii) K-feldspar megacrystic granodiorite grading into alkali-feldspar granite, conforming, essentially, to those previously defined by Cherry. The monzonite is mostly restricted to the west end of the body, in the area mapped by Cherry, and only minor occurrences of possibly equivalent rocks were found farther east. Gower *et al.* (1982b) commented that the close spatial relationships and gradational boundaries between the two groups suggested genetic linkage. The name 'Cartwright alkali-feldspar granite' was used by Kamo *et al.* (1996) for a specific geochronological sampling site in the eastern part of the intrusion. In recognition of the compositional range of

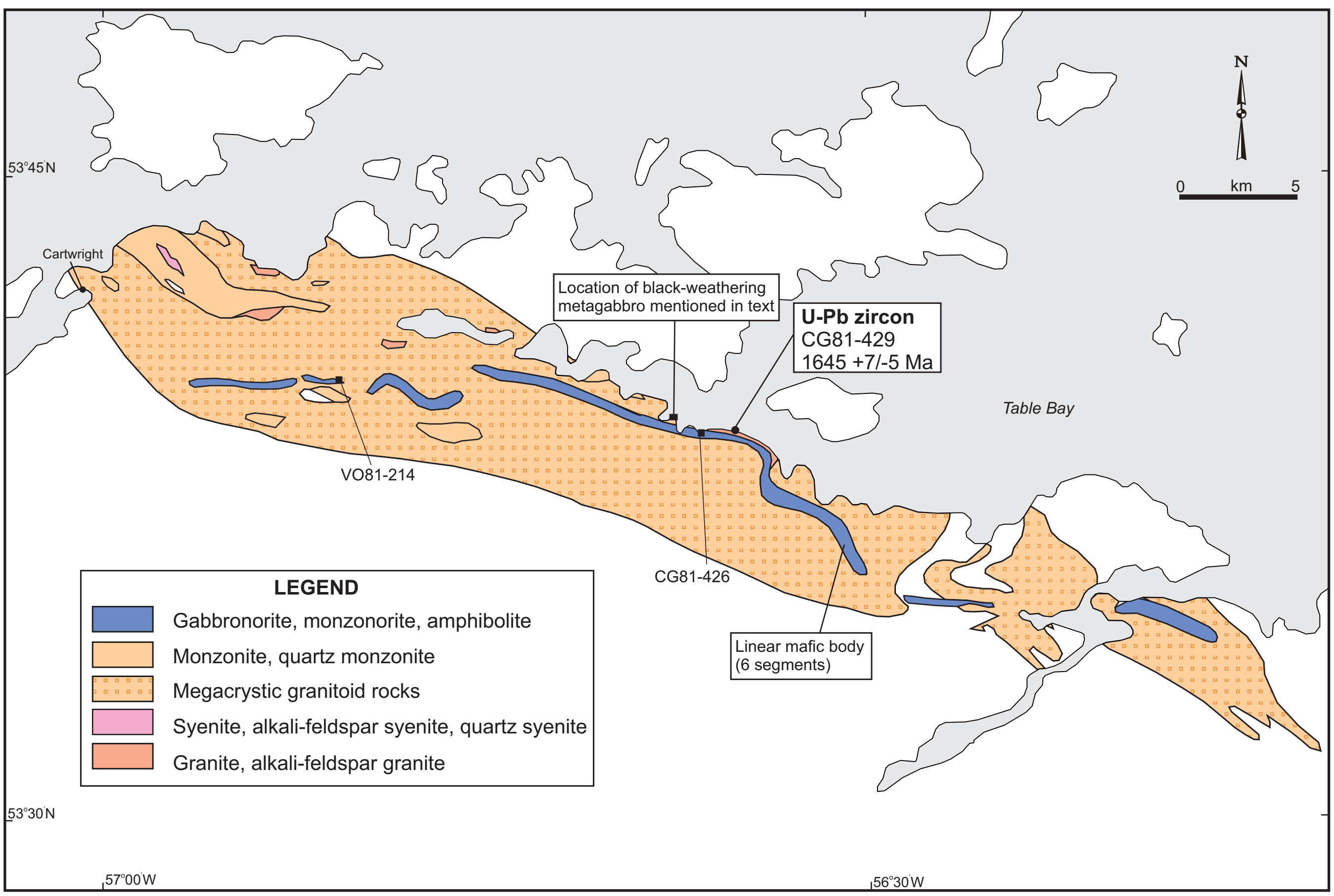


Figure 12.5. *Cartwright intrusive suite.*

rock types present throughout the body, the name is modified here to Cartwright intrusive suite.

The alkali-feldspar granite geochronological sample (CG81-429) remains the only source of age data for the body (Kamo *et al.*, 1996). Three multigrain zircon fractions gave a near-concordant age of 1645 +7/–5 Ma, when regressed with titanite from the same sample having a concordant $^{207}Pb/^{206}Pb$ age of 1020 ± 5 Ma. The upper intercept was interpreted to date time of emplacement and the lower intercept to data time of Grenvillian metamorphism. Sm–Nd analysis (Gower, 2010a; Table Bay map region) of the same sample yielded T_{DM} = 1830 Ma and εNd (1.645 Ga) = +0.74. At the U–Pb geochronological sample site, the 1645 Ma host rock clearly truncates the gneissic fabric of a tonalitic to granodioritic gneiss enclave (Plate 12.2B), thus providing a minimum age of 1645 Ma for the time of migmatization in the gneiss.

Inasmuch as a single generalized description can be applied to the whole body, the rocks are grey- to pink-weathering, medium to coarse grained, and massive to strongly foliated (with localized narrow mylonite zones). The monzonite subunit at the western end of the body also includes quartz monzonite, granite and minor syenite. The K-feldspar megacrystic subunit grades into coarse-grained, non-megacrystic granite and alkali-feldspar granite. Unit designation between megacrystic and non-megacrystic is done with some latitude as the megacrysts are sparse in places and typically small (less than 2 cm in diameter). The megacrysts are stretched, flattened and recrystallized in places.

A feature of the body is the presence of sizable bodies, up to several kilometres long, of less typical rock types (mostly non-megacrystic diorite, monzodiorite and granodiorite). For the most part, it is not really known whether these are rafts of earlier rocks caught up in the Cartwright intrusive suite, or material that is an integral part of the suite's magmatic character. As field notes repeatedly record that the dominant megacrystic rocks are unmigmatized, and many instances were seen of migmatitic quartzofeldspathic gneiss enclaves within an unmigmatized host, it is assumed that, even if contacts are not exposed, migmatization implies that the affected rocks are older. It seems likely that the Cartwright intrusive suite represents a stitching pluton between the Groswater Bay terrane gneisses and the Earl Island intrusive suite, and that it contains material derived from both.

Note that, although enclaves of quartzofeldspathic gneiss are common, enclaves of mafic rocks are much less so. On the other hand, mafic rocks, in the form of intact, but deformed and metamorphosed, dykes occur sporadically throughout the body. One mafic body spatially associated with the Cartwright intrusive suite that is an exception is situated on the south side of the entrance to the narrow, innermost part of Table Bay. It is a shoreline headland outcrop about 0.5 km long that comprises heavy black-weathering metagabbro grading into amphibolite and showing vestiges of igneous texture. It is texturally dissimilar from the linear mafic body that is within the Cartwright intrusive suite (*cf.* Section 15.2) and extends along most of its length, and there is no reason to assume that they are mutually related. An alternative is that it is a large enclave of Adlavik-type mafic rock. The rock was not examined petrographically.

It is commonly mentioned in field notes that the rocks are shattered, sheared, schistose, or otherwise show the effects of cataclasis at modest metamorphic grade. Also mentioned is the presence of microgranite and pegmatite that preferentially show strain, relative to their host rocks, and that the mafic minerals are typically partially or completely chloritized. Coupled with evidence for epidotization and hematization, and the titanite age mentioned earlier, these features are collectively interpreted as evidence for extensive brittle–ductile Grenvillian deformation and emplacement of minor granitoid intrusions at the Hawke River–Groswater Bay terrane boundary.

Finally, it is clarified that, although the Cartwright intrusive suite and the Paradise Arm pluton (Section 12.3.4) have analytically overlapping U–Pb zircon ages, are both megacrystic, and are both designated as P_{3C} granitoid units and may be related in some way, they are not the same. The Cartwright intrusive suite shows: i) much greater rock type variability, including quartz-poor, pyroxene-bearing monzonitic rocks, ii) more common, clearly older, orthogneiss enclaves, iii) fewer mafic and metasedimentary gneiss enclaves, and iv) smaller and sparser K-feldspar megacrysts. These differences suggest, to the author, a contrast in the nature of the crust into which the two units were emplaced (orthogneiss *vs.* paragneiss?) rather than radical genetic difference

12.3.1.2 Petrography

The two subunits identified in the field can be distinguished in thin section by the presence or absence of pyroxene. Thin sections from the monzonite subunit are CG81-011, MC77-002, MC77-059A, MC77-059B and MC77-070A. All of them contain relict igneous clinopyroxene (Photomicrograph 12.1C), and three also have weakly pleochroic orthopyroxene (CG81-011, MC77-002, MC77-070A). Other minerals are plagioclase, K-feldspar (microcline or perthite), quartz, orange-brown biotite, dark-green amphibole, an opaque oxide, apatite, and zircon. The mineral assemblage is relict igneous, but with moderate recrystallization, and is typical of AMCG monzonitic rocks. This is especially true of MC77-002, which is characterized by perthitic K-feldspar, large zircon crystals and evidence of inverted pigeonite.

Thin sections of the K-feldspar megacrystic granodiorite/alkali-feldspar-granite subunit are CG81-425, CG81-429B, CG81-435, CG81-466, VO81-042B, VO81-386, VO81-397, VO81-398, VO81-401B, VO81-421, VO81-497B, VO81-503. Felsic minerals are similar to those in the monzonite, although proportions differ. The contrasts are in mafic and accessory phases. Apart from absence of pyroxene, the granodiorite/granite subunit also differs in lacking amphibole, and having titanite, allanite and epidote. Epidote partly mantles allanite, and, elsewhere, mostly appears to be a part of the stable mineral assemblage. Some is clearly secondary, however, and associated with chloritized mafic minerals.

Four thin sections (CG81-007, CG81-429A, MC77-069A, VO81-001), despite being grouped with the granodiorite/granite subunit because they lack pyroxene, are considered transitional in that they have amphibole, and only sporadically contain allanite and epidote.

Garnet was recorded in one granodiorite/granite (VO81-421) and in one transitional rock (CG81-429A). Garnet was seen in the field at many sites but its status is poorly understood by the author.

12.3.2 HAWKE BAY COMPLEX (P_{3C}dr, P_{3C}gd, P_{3C}gp, P_{3C}am)

The Hawke Bay complex and the Cape Bluff Pond intrusions are situated at the eastern end of the Hawke River terrane, within the Paradise metasedimentary gneiss belt (Figure 12.6). The unit names are newly introduced here. They both contain similar rock types, and are interpreted to be similar in age. They are distinguished because they are geographically separate (except for short segments of common contact), and, although the rock types are similar, their proportions differ. The distribution of rock types within the two units is based on the mapping of Gower *et al.* (1986b, 1987). The earlier reconnaissance maps of Brinex (Piloski, 1955) and Eade (1962) provide no indication of their existence, but, in the vicinity of Martin Bay, Wardle (1976) mapped hypersthene granodiorite, amphibolite gneiss and porphyritic granite, which are now included as part of these bodies. No geochronological data are available.

12.3.2.1 Description

The Hawke Bay complex includes: i) minor ultramafic and metagabbroic rocks, ii) common amphibolite and dioritic rocks, iii) abundant K-feldspar megacrystic and non-megacrystic granitoid rocks, and iv) minor granite. The listed sequence of rock types is also a generalized emplacement-age sequence from older to younger.

A key feature of the Hawke Bay complex is that the earlier units do not form mappable bodies (with a few exceptions), but, rather, occur as an abundant and bewildering assortment of enclaves (also referred to as rafts, blocks, skialiths and schlieren, in a broadly decreasing size progression) that embellish the majority of outcrops within the complex (Plate 12.2C). Enclave shapes are very variable, being angular, lensy or rounded, and all may be present in a single outcrop (*e.g.*, CG86-115). In some outcrops, enclaves are commonly extremely abundant, such that younger invading granitoid rocks are a minor component, and the overall rock is best termed an amphibolitic or dioritic agmatite. The range of rock types forming the enclaves is also extremely variable and is addressed below.

The ultramafic enclaves (seven localities) were recorded as 'hornblendite' in field notes, utilizing the term in a metamorphic sense for a rock composed almost entirely of polygonal amphibole.

One thin section examined (GM85-426B) comprises about 90–95% pale-green amphibole (Mg-rich hornblende?), relict strongly pleochroic orthopyroxene and an opaque oxide. No olivine was found in any rock of the Hawke Bay complex.

Gabbroic enclaves (18 localities) include melagabbro, gabbronorite and leucogabbro. Vestiges of primary igneous layering were noted at one locality (CG85-455).

One of the four gabbroic rocks examined in thin section, a melagabbro originally (CG85-461B), is closely allied to the ultramafic rocks, in that it mostly consists of amphibole (both tremolite and pale-blue-green actinolitic amphibole). The other three (CG85-449, GM85-459C, JS86-360A) are mutually texturally very similar, showing relict coarse-grained ophitic texture, despite almost all pyroxene having been pseudomorphed by amphibole. These rocks also contain orange-brown biotite and minor quartz, and one of them (CG85-449) is transitional to diorite.

The most common mafic rock is amphibolite (305 localities), embracing a texturally wide range of metamorphosed mafic rocks. It occurs as enclaves and larger, mappable occurrences. The amphibolite may be fine, medium or coarse grained; massive and homogeneous; variably migmatized; show relict primary igneous layering; or have fine laminations or broader banding. It may be broken up into angular to rounded blocks to form an agmatite, or be assimilated and deformed to varying degrees by the host granitoid rock and have a much more migmatitic or gneissic aspect. The leucosome associated with the migmatized amphibolite is fine to coarse grained, weakly to strongly foliated, and commonly contains hornblende. Most of the field evidence indicates that the amphibolite is an early formed rock type, being enclosed as deformed xenoliths in the granitoid rocks, or, where the outcrop is mostly amphibolite, being injected by granitoid material. The finely laminated and banded amphibolite is interpreted to be of supracrustal origin, by comparison with metamorphosed mafic volcanic rocks within the Paradise metasedimentary gneiss and the presence of enclaves of metasedimentary gneiss as diffuse, nebulitic rafts or disoriented blocks. For the majority of outcrops, evidence of primary origin is lacking, however. Conversely, at several outcrops it is clear that the amphibo-

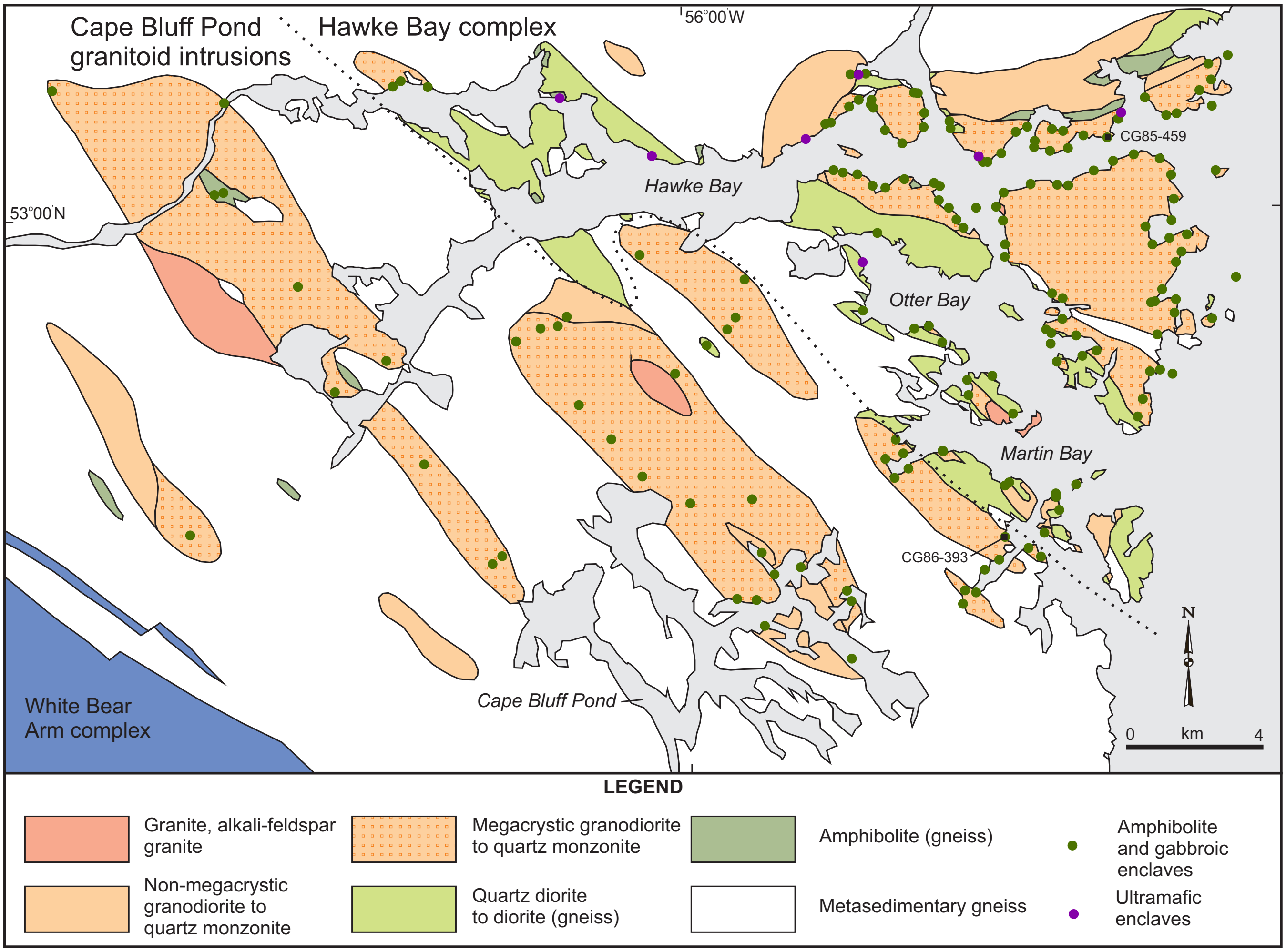


Figure 12.6. *Hawke Bay complex and Cape Bluff Pond granitoid intrusions.*

lite represents former mafic dykes (CG85-462, CG86-346, CG86-395, GM85-377, JS86-317, JS86-326, JS86-330, JS86-355, SN86-289, SN86-290, VN85-398, VN85-431, VN85-455, VN85-483). Some of these are described as net-veined, others as boudinaged or folded.

Two amphibolite samples were examined in thin section (CG86-490, GM85-395). Both are straightforward rocks consisting mainly of plagioclase and hornblende, with lesser biotite, minor quartz and accessory phases.

Dioritic rocks (320 localities) in the Hawke Bay complex (including quartz diorite, dioritic gneiss and migmatized diorite), are a confusing and difficult-to-map group. The northwest-trending belt of dioritic rocks shown in Figure 12.6 is only a crude generalization of their distribution. They are as texturally variable as the amphibolite, but are distinguished from them by having lower colour indices and higher quartz content. The more melanocratic varieties grade into gabbroic rocks, whereas the leucocratic versions, which carry minor K-feldspar, grade into granodiorite. They typically carry enclaves of mafic rocks in various stages of assimilation, but themselves occur as enclaves in other granitoid rocks.

Of the 19 samples thin sectioned, four were termed diorite (GM85-427, GM85-471B, JS86-359, MN86-304), eight were termed quartz diorite (CG85-461A, GM85-393, GM85-396, GM85-430A, GM85-430B, SP85-022, VN85-398, VN85-410), two were termed tonalite (CG85-426, GM85-378), two are transitional between quartz diorite and granodiorite (GM85-454A, GM85-462), and three orthopyroxene- and quartz-bearing samples (CG86-368, GM85-471A, VN85-450) could be termed opdalite (hypersthene granodiorite) (*cf.* Wardle, 1976). Apart from prevalence of quartz, and the presence of orthopyroxene or K-feldspar, the dioritic rocks have very similar mineral assemblages to the amphibolite, with the sporadic addition of accessory allanite and epidote.

Granodioritic to granitic rocks can be subdivided into non-K-feldspar-megacrystic (251 localities) and megacrystic varieties (351 localities). There is no reason to consider the two as genetically distinct, except for whatever implications the distribution of the megacrysts implies. Gradations between the two are commonly seen, and non-megacrystic and megacrystic granodiorite may form alternating zones. The rocks are locally weakly, or, rarely, even strongly foliated (typically in localized shear zones), but, for the most part, they are described in field notes as pink to buff, massive or homogeneous, medium to coarse grained, and, rarely, diffusely banded. Lack of deformation or recrystallization is demonstrated by K-feldspar megacrysts being well-shaped and zoned. They range in size up to about 5 cm long. Outcrop heterogeneity is introduced by the pervasive amphibolitic and dioritic enclaves, schlieren and metamorphosed mafic dykes described above.

Thin sections of seventeen samples (CG85-448, CG85-466, CG85-471, CG85-475, GM85-364, GM85-450, GM85-457, GM85-458A, GM85-458B, GM85-461, GM85-464, GM85-468, GM85-469, GM85-472, MN86-309, MN86-334, MN86-343B) all contain plagioclase, quartz, K-feldspar (microcline), olive-green biotite, an opaque oxide, apatite, zircon, and some have allanite and epidote. Hornblende was recorded in three samples that are transitional into quartz monzonite.

The associated minor granite listed earlier occurs as minor intrusions of pink granite, aplite and pegmatite. These are typically undeformed and obviously have late-stage emplacement. Some pegmatites are muscovite bearing. One 1-m-wide quartz vein was also recorded.

12.3.2.2 Age and Origin

Despite a lack of geochronological data for the Hawke Bay complex, some inferences regarding its age can be made. The migmatized state of the mafic and dioritic rocks testifies to a period of deformation and metamorphism that the granodioritic and granitic plutonic rocks of the complex largely escaped. It is known from Labradorian titanite ages farther north in the Hawke River terrane that post-Labradorian orogenesis (*i.e.*, Pinwarian or Grenvillian) was moderate. This means that the migmatization was Labradorian or earlier. Regionally, the time of the main period of Labradorian orogenesis was *ca.* 1665 Ma. The K-feldspar megacrystic rocks are very similar to those in the Paradise Arm pluton, which have an age of 1639 ± 2 Ma (Kamo *et al.*, 1996). It seems highly probable to the author that the Hawke Bay complex is similar in age to the Paradise Arm pluton. The regional plunge in the Paradise metasedimentary gneiss belt is southeast, based on metamorphic assemblages and structural data. This implies that the Hawke Bay complex is a relatively high-level plutonic body. Note that no garnet is found anywhere in the body and that epidote is a stable phase in some rocks. The late-stage minor granitic intrusions might be late Labradorian, or could be younger. Given the progression of younging rock compositions with increasing Si and K, it seems sensible to consider them to be late Labradorian, in which case Grenvillian deformation is largely lacking.

Deciphering the origin(s) of the enclaves, and understanding the process of their incorporation into the granitoid intrusion, would make this magmatic cauldron a marvellous and challenging research project. Until that is done, however, the reader must put up with the author's interpretation (*cf.* Gower *et al.*, 1986b). This envisages the Paradise metasedimentary gneiss belt to be the supplier of all the material needed to produce the rocks present. Mafic volcanic rocks and associated mafic dykes in the Paradise metasedimentary gneiss belt, comparable to those well exposed in the Dead Islands area to the south, could be the source of the mafic material. The enveloping pelitic gneisses would provide the most easily melted source for large quantities of granitoid magma. The dioritic rocks in the Hawke Bay complex are suggested to be the product of assimilation of mafic volcanic material with the granitoid magmas. The enclaves represent unassimilated, or partially assimilated, remnants of the mafic volcanic rocks and the refractory part of the metasedimentary gneiss.

12.3.3 CAPE BLUFF POND GRANITOID INTRUSIONS (P_{3C}gp, P_{3C}gd, P_{3C}ga)

The Cape Bluff Pond granitoid intrusions form a cluster of northwest-trending, elongate granitoid plutons consisting mostly of K-feldspar megacrystic granodiorite-granite rocks, but including non-megacrystic granodiorite, alkali-feldspar granite, and minor dioritic material (Figure 12.6). They were first mapped by Gower *et al.* (1985, 1986b), except for an area in the vicinity of Cape Bluff Pond previously mapped by Wardle (1976).

As in the Hawke Bay complex, the granitoid rocks are host to amphibolite and diorite enclaves. At a few outcrops, the enclaves are described as numerous, but, in general, they seem less abundant than in the Hawke Bay complex, although this might be partly an artifact of inland *vs.* coastal exposure. The range in shape, size, migmatized character, and enclave rock types is comparable to that seen in the Hawke Bay complex. More common mention in field notes of diffuse enclaves, biotitic schlieren, or biotite-rich zones prompts the thought that assimilation is more advanced in the Cape Bluff Pond intrusions. Net-veined amphibolite mafic dykes were recorded at CG86-369 and fine-grained amphibolite dykes at VN85-375.

The granitoid rocks are also similar. The K-feldspar megacrystic granitoid rocks are mostly weakly deformed or massive, have a fine- to coarse-grained matrix, and have euhedral and zoned megacrysts up to 5 cm long (Plate 12.2D). Magnetite clots measuring 5 by 3 cm were noted at CG86-245 (such concentrations of magnetite are common in the surrounding metasedimentary gneiss). Locally, gradational transitions into non-megacrystic units were recorded.

The megacrystic/non-megacrystic granitoid rocks are intruded by alkali-feldspar granite dykes and larger irregular bodies, and granite pegmatite.

One amphibolite (VN85-375), two quartz diorite to tonalite samples (CG86-112, CG86-140), six K-feldspar megacrystic granites (CG86-128, CG86-134, CG86-244, CG86-248, MN86-117, VN86-294), and two non-megacrystic granites (CG86-120, MN86-121) from the Cape Bluff Pond granitoid intrusions were examined in thin section. Petrographic details are similar to those for rocks of the Hawke Bay complex. Of special note is orthopyroxene in three granitoid samples (CG86-120, CG86-140, MN86-117). Sample CG86-140 is also exceptional in having hornblende and clinopyroxene, whereas all other granitoid samples only have orange-brown biotite. The lack of hornblende in the Cape Bluff Pond granitoid intrusions *vs.* its presence in the Hawke Bay complex is more-so an artifact of it being concentrated in the abundant dioritic rocks in the Hawke Bay complex. Hornblende is lacking in the megacrystic/non-megacrystic granodiorite/granite of both groups of rocks.

12.3.4 PARADISE ARM PLUTON (P_{3C}gp)

12.3.4.1 Description and Age

The Paradise Arm pluton is a megacrystic granitoid unit within the Hawke River terrane. The pluton has a northwest trend and a lenticular shape, being 120 km long and having a maximum width of about 10 km (Figure 12.7). It is flanked by the White Bear Arm complex (WBAC) on its southwest side, and the Paradise River metasedimentary gneiss belt (PMGB) on its northeast side (or, for a short segment, the Sand Hill Big Pond (SHBP) anorthositic to gabbronorite intrusion) (Figure 7.6). With the possible exclusion of the SHBP intrusion, contacts with adjacent units are suspected to be ductile faults. Gower *et al.* (1986b) interpreted the Paradise Arm pluton to have been emplaced by wedging apart the PMGB and WBAC, at which time the SHBP intrusion became isolated from the WBAC.

The first indication of the pluton's existence was provided by Cherry (1978a), who, in his post-field-season report, depicts two areas of granodiorite augen gneiss (his Unit 3) south of Sandwich Bay that approximately correlate with parts of the northwest end of the Paradise Arm pluton (only one of these is shown on his 1:100 000-scale geological map; Cherry, 1978b). The body was not recognized as a discrete entity during mapping by Brinex (Piloski, 1955) or Eade (1962), although Eade mentions that some of the granitoid rocks in his broader unit are megacrystic. During the course of four 1:100 000-scale mapping projects in the region, the pluton was progressively mapped from northwest to southeast by Gower *et al.* (1982b, 1985, 1986b, 1987). The name Paradise Arm pluton was introduced by Gower *et al.* (1985).

The pluton has been precisely dated (Figure 12.7) by Kamo *et al.* (1996; sample CG85-280). Two multigrain zircon fractions and one single zircon gave a concordant ^{207}Pb/^{206}Pb age of 1639 ± 2 Ma, interpreted to date time of emplacement. Two single monazite grains and one fraction of two monazite grains gave concordant and near concordant ages of 1631 ± 2, 1621 ± 1 and 1613 ± 2 Ma, which were suggested to represent subsequent thermal events. Earlier, Prevec *et al.* (1990) reported an Rb–Sr whole-rock isochron age of 1573 ± 40 Ma (I_{Sr} = 0.7043) based on six samples, one of which (SPM86-14) is from the same locality as that sampled for U–Pb analysis. Prevec *et al.* (1990) also obtained Sm–Nd isotopic data for two samples from the pluton (SPM86-12A, SPM86-14). These yielded T_{DM} ages of 1982 and 1960 Ma and εNd (1.65 Ga) values of +0.3 and +0.5, respectively.

The dominant rock type in the pluton is a white, pink or grey, homogeneous, massive to mylonitic, K-feldspar megacrystic granitoid rock having a medium- to coarse-grained matrix. K-feldspar megacrysts range from 1 to 8 cm in diameter and make up to 40% of the rock. Numerous stained slabs demonstrate that the K-feldspar is almost entirely restricted to the megacrysts and is lacking in the rest of the rock (Appendix 2, Slab images 12.3). A similar characteristic applies to the megacrystic rocks in the Hawke River complex, the Cape Bluff Pond granitoid intrusions and The Backway megacrystic granitoid rocks, and is interpreted by the author to mean genetic linkage.

Sporadically, plagioclase megacrysts up to 1 cm in diameter are also seen. Partly because of variations in megacryst abundance, the rocks can be variably termed granodiorite, granite, monzogranite and syenogranite. The pluton is also characterized by blue quartz in places and, overwhelmingly, biotite is the mafic silicate. Despite the pluton mostly seeming to be massive or weakly deformed, the effects of deformation should not be underrated, particularly at the northwest end of the pluton on its western side, or marginal to other rock types elsewhere. In the northwest region, the megacrysts are commonly elliptical augen (Plate 12.3A), or even reduced to polygonal aggregates, and quartz may be stretched into ribbons. Zones of severe mylonitization occur in places, but are generally narrow, being typically less than 3 m wide. Incipient migmatization is also evident in the same areas. Non-megacrystic lithological granitoid variants of the Paradise Arm pluton occur locally, especially near the interface with the SHBP intrusion and, less commonly, adjacent to the WBAC. These include small bodies of monzonorite (Section 11.4.4.8), plus rocks variously termed in field notes as monzonite, mangerite, monzodiorite or charnockite.

Other features of the Paradise Arm pluton are mafic or metasedimentary gneiss enclaves, metamorphosed mafic dykes and minor granitoid intrusions. Mafic enclaves are

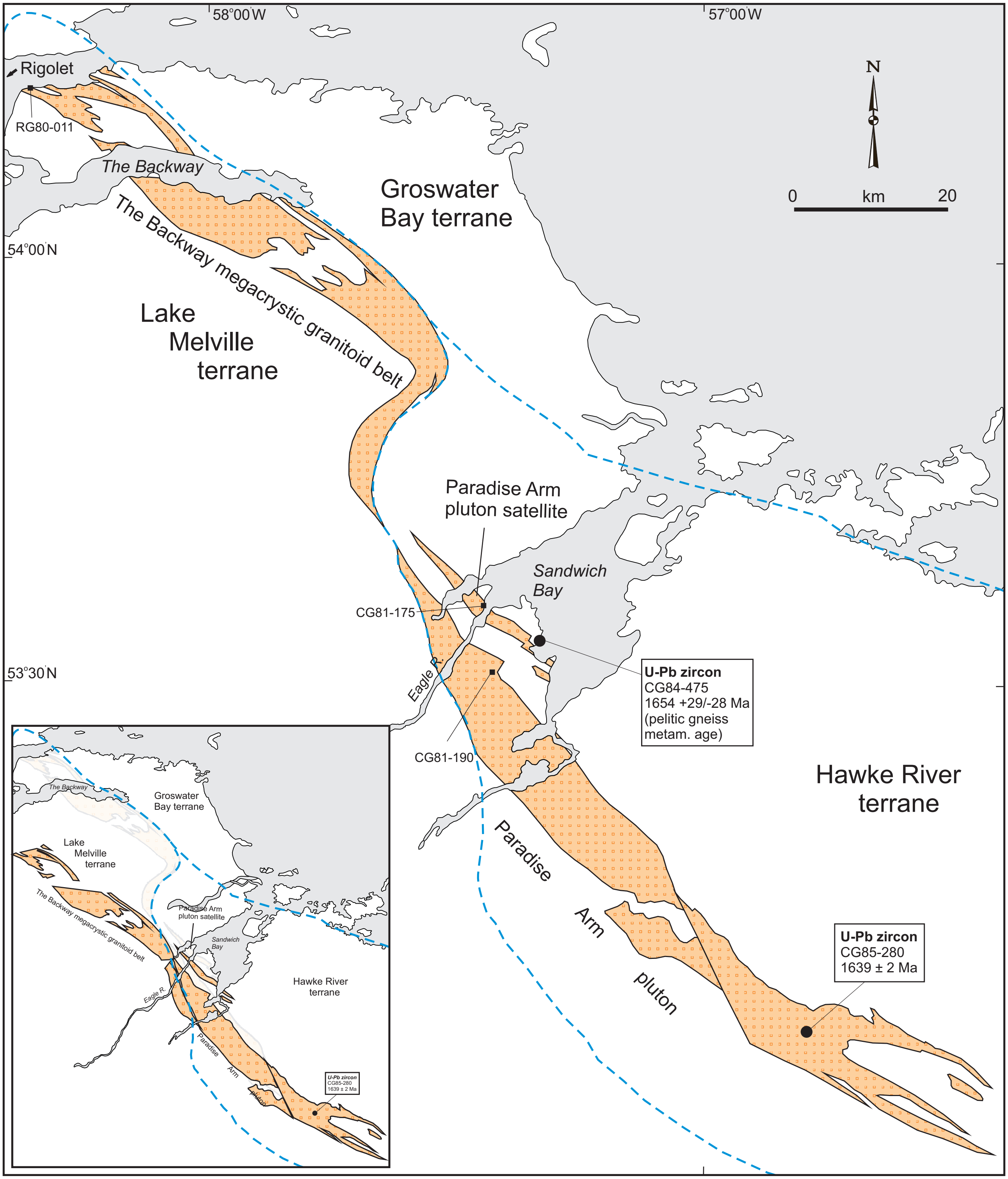


Figure 12.7. *Paradise Arm pluton and The Backway megacrystic granitoid belt. Inset shows how the two units may be related, by restoring to pre-40-km-dextral-fault configuration.*

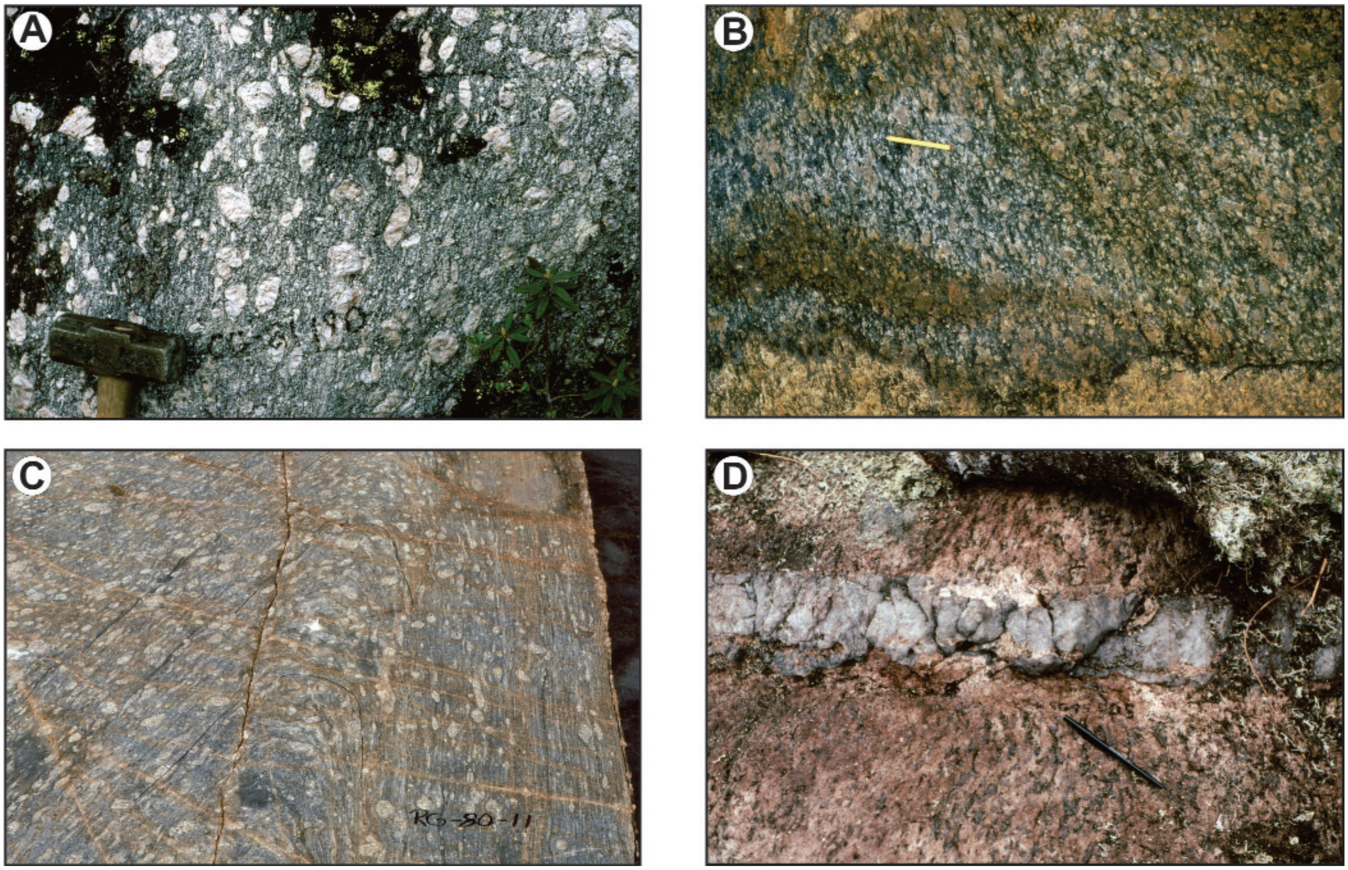


Plate 12.3. *Examples of late-Labradorian granitoid intrusions in the Hawke River, Lake Melville and Mealy Mountains terranes. A. Paradise Arm pluton; K-feldspar megacrystic to porphyroclastic (CG81-190), B. Paradise Arm pluton satellite; K-feldspar megacrystic (CG81-175), C. The Backway K-feldspar megacrystic/porphyroclastic granitoid rock showing folding. Mafic dyke on right edge of image (RG80-011), D. Middle Eagle River alkali-feldspar granite hosting quartz-rich pegmatite (CG95-005).*

fairly common and are mostly fine- to medium-grained amphibolite, but metagabbro and diorite are also found. The amphibolite may be massive, strongly foliated, gneissose or net-veined. Interesting contact relationships between mafic rocks and the megacrystic host granitoid are seen at VN84-189. At this locality, mafic rocks have been agmatically intruded by K-feldspar megacrystic granitoid rocks, in the process creating well-defined reaction rims at the mafic-felsic interface (*cf.* also Plate 11.5A, B). The most common type of metasedimentary enclave is sillimanite-bearing pelitic gneiss, but schistose biotite-muscovite-rich material and quartzofeldspathic rock of uncertain (psammitic or granitoid) protolith are also present. Both metamorphosed mafic dykes (CG81-183, SN86-085, SN86-090, VN84-301, VN84-189, VN84-370), and minor granitic intrusions are sparse. One mafic dyke, now amphibolite (SN86-085) was described in the field as 4 m wide, unfoliated, unmigmatized, and having a chilled margin.

12.3.4.2 Petrography

Petrographically, the Paradise Arm pluton can be subdivided into: i) K-feldspar megacrystic granitoid rocks, ii) granite, iii) monzonite, monzodiorite and tonalite, iv) mafic enclaves and(or) dykes, v) metasedimentary gneiss enclaves.

Given the modest variability of the megacrystic granitoid rocks, an unjustifiably large collection of thin sections is available (CG81-188, CG81-283, CG84-378, CG85-195, CG85-254, CG85-280, CG85-283, GM85-171, GM85-187, GM85-224, GM85-243, LC85-001, LC85-002, MC77-087A, MC77-183A, MC77-211A, MC77-211A, NN84-318, SN86-085A, SN86-091, VN84-001B, VN84-017, VN84-189A, VN84-354, VN84-381, VN84-383, VN85-219, VN85-229, VN85-230, VN85-231, VN85-300). The felsic minerals are relict igneous and metamorphic plagioclase, K-feldspar (almost all microcline) and quartz. Biotite (olive-green to orange-brown) is present in all samples, except for one where it has been entirely chloritized. Other mafic silicates mentioned in field notes or in post-field-season reports (hornblende, orthopyroxene and garnet) are rare in thin section. Hornblende was seen in two sections, orthopyroxene not at all, and garnet in four thin sections. Two of the garnet-bearing thin sections (VN85-230, VN85-231) are very close to a probable intrusive contact with metasedimentary gneiss, so contamination is suspected. All megacrystic granitoid samples contain an opaque oxide, but only two contain sulphide. Titanite is present in about half of the samples, commonly seen mantling the opaque oxide. Apatite and zircon are almost universally present, and, slightly less commonly, also allanite and epidote (epidote is secondary in some samples). Other secondary minerals are white mica and chlorite. One mineralogical oddity is scapolite in SN86-091, which, otherwise, is a sample typical of the Paradise Arm pluton. The site is very close to the WBAC, which may be an inculpatory factor.

Granite in the Paradise Arm pluton is mineralogically similar to the megacrystic granitoid units, except for lacking K-feldspar megacrysts, and having more quartz and less biotite. Accessory and secondary minerals are similar (thin sections MC77-210A, MN86-087, VN84-255, VN84-367B, VN84-368, VN84-389, VN85-233). Minor amphibole is present in VN84-255, and clinopyroxene in MN86-087. Sample VN84-255 is spatially associated with a cluster of other non-megacrystic rocks, which, collectively, may reflect a xenolithic raft within the Paradise Arm pluton. Data station MN86-087 is very close to the WBAC, and, perhaps, should not be included with the Paradise Arm pluton at all.

Monzonite, monzodiorite and tonalite samples (CG85-193, CG85-215, VN84-175, VN85-316, VN84-370C) all carry hornblende in addition to biotite, except for CG85-215, which has orthopyroxene instead (due to contamination by the nearby metasedimentary gneiss?). Garnet is present in VN84-175. These sample sites are also close to either the WBAC or SHBP intrusion.

Five samples of mafic rocks were examined in thin section (CG84-376, SN86-085B, VN84-189E, VN84-189F, VN85-315A). The rocks are clinopyroxene- and biotite-bearing amphibolite, and, despite a largely metamorphic mineral assemblage, they show vestiges of ophitic igneous texture, apart from CG84-376, which is thoroughly metamorphic. Plagioclase and quartz form relict phenocrysts in VN84-189E, and plagioclase has skeletal habit in VN84-189F. This locality was mentioned earlier as having mafic rocks injected by megacrystic granitoid material. Given the skeletal-plagioclase evidence for mafic-magma quenching, a case can clearly be made for magma mingling.

Of the samples grouped as having a metasedimentary protolith, four are pelitic schist or gneiss (CG84-372A, CG85-272, EA61-074 – sillimanite bearing, MW84-084), whereas three have a more uncertain psammitic or granitoid protolith (MC77-104C, MC77-182A, VN84-160).

12.3.4.3 Origin

Prevec (1987) concluded from petrographic and trace-element data, that the Paradise Arm pluton was cogenetic and comagmatic with the granitoid rocks of the WBAC. This position is endorsed by the author, emphasizing U–Pb geochronological data (not available to Prevec), which confirms that the two groups of rocks are coeval, both having been emplaced at *ca.* 1640 Ma. Indications of mafic–felsic magma mingling, such as that demonstrated at VN84-189, and probably near-synchronous mafic dyke emplacement elsewhere (*e.g.*, SN86-085), provide corroborative evidence. Prevec (1987) and Prevec *et al.* (1990) suggested that partial melting of the PMGB could have been the source for some of the granitoid magma, which the presence of metasedimentary gneiss enclaves and 'aberrant' granitoid rocks close to contacts with metasedimentary gneiss would support.

12.3.5 PARADISE ARM PLUTON SATELLITE (P_{3C}gp)

The Paradise Arm pluton satellite is located in the southwest part of Sandwich Bay within the Paradise metasedimentary gneiss belt in the Hawke River terrane. The body is a northwest-trending lenticular body, 27 km long by 2 km wide, parallel to the northwestern end of the Paradise Arm pluton. It is a megacrystic granitoid unit lithologically very similar to the Paradise Arm pluton, hence the term 'satellite'; but it might equally be a tectonically dismembered and repeated part of it, rather than an originally separate, smaller pluton. Very small, flanking slivers of K-feldspar megacrystic rocks are also included here.

An attempt was made to date the body using Rb–Sr whole-rock methods by Brooks (1983). Six samples were collected from outcrops along the Eagle River shoreline and collectively defined an errorchron date of 1555 ± 195 Ma (I_{Sr} = 0.7036), which is more-or-less comparable to the 1573 ± 40 Ma (I_{Sr} = 0.7043) age that Prevec *et al.* (1990) reported for the Paradise Arm pluton itself. The data of Brooks are somewhat scattered, and selected removal of individual points (without any real justification) yields alternative dates that are nominally roughly 100 million years older or younger. The only other relevant geochronological data in the area is a U–Pb age of 1654 +29/–28 Ma (Schärer and Gower, 1988) from the enveloping metasedimentary gneiss that is best considered as dating time of metamorphism. On the basis of present information, the preferred interpretation is that the satellite body is coeval with the 1639 Ma the Paradise Arm pluton.

The body is mostly a pink-, white- or grey-weathering, medium- to coarse-grained, massive to mylonitic, K-feldspar megacrystic biotite granodiorite to granite. K-feldspar megacrysts are mostly less than 2 cm long, but up to 8 cm long were recorded at CG81-159. Megacryst shape, which varies from euhedral to ovoid, is related to the very variable deformational state (Plate 12.3B). Local narrow zones of intense strain are evident in places. The megacrystic unit is interlayered with granitoid gneiss and amphibolite at its fringes. Amphibolite enclaves and minor granitoid intrusions are not abundant, but do occur. Folded and boudinaged remnants of a metamorphosed mafic dyke were recorded at CG81-165, and partly assimilated amphibolite lenses at CG81-220. These mafic remnants should not be confused with unmetamorphosed younger mafic dykes that intrude the megacrystic granitoid rocks in the same area, namely a Long Range dyke at the mouth of White Bear

River and Sandwich Bay mafic dykes along the shores of the mouth of Eagle River.

The first 8 of the 12 listed thin sections available for this 'satellite' body (CG81-160A, CG81-160B, CG81-161B, CG81-162, CG81-162A, CG81-162B, CG81-175, CG81-175A, CG81-221, CG81-280, MC77-101B, MC77-105A) were collected for the Rb–Sr investigation from a relatively small area near the mouth of Eagle River. As the intent was to have a consanguineous suite, it is not surprising that petrographic commonality exists. The rocks consist of plagioclase, microcline, quartz, olive-green to orange-brown biotite, very minor hornblende in CG81-162, an opaque oxide, and accessory apatite, zircon, titanite and allanite, and secondary phyllosilicates. Departures from this mineral assemblage are seen in samples away from the Eagle River cluster, for example in MC77-101B, which has hornblende, and CG81-280, which has garnet. The latter sample is close to metasedimentary gneiss and could be contaminated by it. The only other rock examined in thin section is amphibolite from CG81-211, a site also investigated paleomagnetically. The sample is from a metamorphosed mafic dyke and contains plagioclase, hornblende, an opaque oxide, minor sulphide, and secondary carbonate in veins.

12.4 LAKE MELVILLE TERRANE

12.4.1 THE BACKWAY MEGACRYSTIC GRANITOID BELT (P_{3C}gp)

The Backway megacrystic granitoid belt extends about 90 km in a southeast direction from Rigolet, within the Lake Melville terrane (Figure 12.7). It was outlined during 1:100 000-scale mapping (Gower *et al.*, 1981, 1982b). The belt crosses the eastern part of The Backway, hence its name (newly introduced here). No geochronological data are available for the unit.

The most typical rock within the belt is a pink-weathering, medium- to coarse-grained, moderately foliated to mylonitic, garnet-, biotite-, hornblende-bearing, K-feldspar megacrystic granodiorite. A key feature is abundance of garnet, which may reach 15–20% of the rock. The garnets are euhedral or anhedral and form clusters up to 1 cm in diameter. K-feldspar megacrysts show variation in size, shape and abundance. Commonly they are in the 2–3 cm range, but may be up to 7 cm in diameter. Shape, related to deformational state, varies from euhedral to elliptical (Plate 12.3C). Some megacrysts have been reduced to recrystallized aggregates of smaller grains. In places they are extremely abundant – field estimates claim up to 40% of the rock. The megacrystic granitoid rocks were intruded by mafic dykes, commonly now seen as isoclinally folded layers or boudinaged lenses, slivers or pods. The mafic rocks are also garnet bearing. Pegmatites discordantly intrude the unit.

A petrographic study of 17 thin sections (CG80-014A, CG80-085B, CG80-458, CG80-808, CG81-475, EA61-432, NN80-549B, NN80-559, RG80-011, RG80-016, RG80-030, RG80-036, RG80-118, RG80-298, RG80-302A, RG80-467A, SGJ68-063) shows the unit to be fairly uniform. The rocks are mostly termed granodiorite gradational into granite, and locally into monzonite. The mineral assemblage comprises plagioclase, microcline K-feldspar, quartz, orange-brown biotite, green-brown hornblende, garnet, an opaque oxide, apatite, zircon, sporadic allanite, and secondary titanite, epidote, white mica and chlorite. Hornblende is minor, but much more consistently present than field descriptions would lead one to expect. Garnet in these rocks is characterized by opaque mineral and quartz inclusions. One anomalous thin-sectioned sample is CG80-005, in that it contains clinopyroxene and has a monzonitic composition. It may well be unrelated.

Five rocks from within the belt are interpreted to be metasedimentary gneiss enclaves, although, in some instances, lack of other outcrops nearby could mean these rocks are more extensive than presently implied. Three of the samples (CG81-239, RG80-490, SG68-1080 are sillimanite-garnet-bearing pelitic gneiss, one of which also contains kyanite; one is interpreted to have a greywacke, or possibly tonalitic, protolith (RG80-237); and one to have a calcareous protolith (CG80-089). Two mafic rocks were also examined (CG80-013, CG80-014B). Their mineral assemblages include hornblende, clinopyroxene and garnet and are clearly high-grade metamorphic rocks. Both come from concordant layers within gneissic rocks. Their protolith is equivocal, and a supracrustal origin cannot be ruled out.

12.4.1.1 Paradise Arm – The Backway Granitoid Unit Correlation

A tempting interpretation is that the Paradise Arm pluton and The Backway megacrystic granitoid belt originally formed a single body, which was dismembered by dextral transposition during Grenvillian orogenesis (Figure 12.7 inset). The reconstruction in the inset necessitated 'straightening-out' the bent southern tail of The Backway unit. Note that a parallel fault to the southeast cutting across the Paradise Arm pluton shows the same sense of displacement. Recall also that metasedimentary gneiss south of The Backway was tentatively correlated with rocks having similar mineral assemblages at the north end of the Paradise metasedimentary gneiss belt (Section 7.3.5.1) – the reconstruction would bring them together. Similarly, the White Bear Arm complex correlative (Section 11.4.5.1) is restored as part of the WBAC.

The dismemberment resulted in transfer of the northern half the body from the Hawke River to Lake Melville terrane and a *ca.* 40-km offset on either side of the boundary between them. The abundance of garnet in The Backway megacrystic unit (especially its northern part) suggests that the dextral displacement was accompanied by crustal exhumation in the north.

Such a model is consistent with regional indentor-corner Grenvillian deformation in the Lake Melville terrane (Chapter 23).

12.5 MEALY MOUNTAINS TERRANE

12.5.1 MIDDLE EAGLE RIVER PLUTON (P_{3C}mq, P_{3C}ga)

The term 'Middle Eagle River pluton' is newly introduced here for a mostly granitoid body that straddles corners of four 1:100 000-scale map regions (northwest – Southeast Mealy Mountains; northeast – Paradise River; southwest – Eagle River; and southeast – Alexis River (Figure 12.8). In consequence of it having been mapped in segments at various times, existing descriptions of it lack coherence. The rocks have been termed: i) hornblende quartz monzonite to granite in the northwest (Gower and van Nostrand, 1996), ii) granodiorite in the northeast (Gower *et al.*, 1985), iii) granite to alkali-feldspar granite in the southwest (Gower, 1998), and iv) syenite to quartz syenite in the east (van Nostrand, 1992). Following examination of new roadcuts by the author in 2007, coupled with more detailed assessment of earlier collected stained slabs and thin sections, the body is now subdivided into two north-northwest-trending parts, namely 'granite, alkali-feldspar granite and quartz syenite' in the west and 'monzonite, quartz monzonite and quartz syenite' in the east. A small area of quartz monzonite on the west flank of the granite has also been included as part of the body. There are also a few mafic rocks within both parts of the body.

12.5.1.1 Isotopic Data

A sample (CG84-317) from the northern section of the monzonitic part of the body was dated by Schärer and

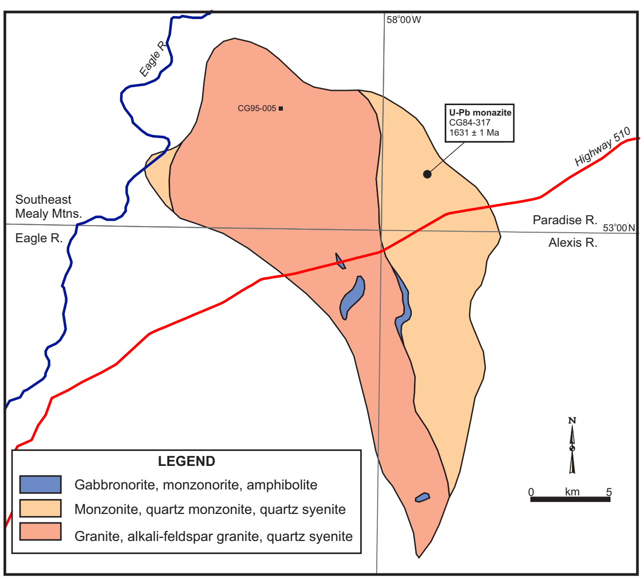


Figure 12.8. *Middle Eagle River pluton. Boundaries and names of four 1:100 000-scale map regions indicated.*

Gower (1988). The rock, termed hornblende granodiorite, yielded a concordant monazite age of 1631 ± 1 Ma. Two discordant multigrain zircon fractions from the same rock gave $^{207}Pb/^{206}Pb$ minimum ages of 1735 and 1718 Ma. The monazite ages was interpreted as dating the time of emplacement of the body and the two zircon fractions were considered to be inherited (possibly from the Eagle River complex; Chapter 8).

Four whole-rock Sm–Nd results are available. One result is from the granite (RH-013) and gives T_{DM} of 1678 Ma and εNd = +3.5. The other three are from the monzonitic part of the body (CG07-012B, CG84-317, RH-012) and give εNd = +2.3, +4.0 and +1.9 and T_{DM} ages = 1.784, 1.646 and 1.832 Ma, respectively.

12.5.1.2 Field Description

The granite in the west weathers pink, white, creamy or buff, is coarse grained, recrystallized, homogeneous and moderately to strongly foliated (Plate 12.3D). It contains a few mafic and fine-grained granitic enclaves and is sparsely intruded by now-deformed pegmatite. These carry the same foliation as their host rock. It was described as K-feldspar seriate to megacrystic at a few localities. The monzonite to quartz monzonite in the east weathers white, creamy or brown (rarely pale-pink), is medium to coarse grained, recrystallized, broadly homogeneous and strongly foliated. Pegmatite is rare and mafic enclaves sparse. A small body of granitoid gneiss was also mapped within the monzonite.

Some bodies of amphibolite/mafic granulite (one 3 km long) are shown within the granite on the 1:100 000-scale map, but their exact extents are approximate and require further verification. Also, a 5-km-long, narrow lensoid mass of mafic rock is indicated on the 1:100 000-scale map along part of the interface between the granite and monzonite segments of the body. The rock shows primary igneous layering and although it mostly comprises leucogabbronorite to anorthosite, it also contains some melanocratic gabbronorite (CG91-006, VN91-424). The relationship between the mafic and granitoid rocks within the Middle Eagle River pluton is unknown.

Five thin sections from the granite are available (CG95-005, CG97-038, CG97-040, EA61-069, VN95-001). All contain well-twinned plagioclase, perthitic K-feldspar (string, flame and bead types), quartz, dark-green hornblende, an opaque oxide, apatite and zircon. Clinopyroxene is present in all except CG95-005. Orange-brown biotite is present in three thin sections, being absent from CG97-038 and CG97-040, which have fayalite instead. Orthopyroxene is present in VN95-001.

Five thin sections of monzonite (CG84-319, CG07-012B, CG84-315, CG91-004, VN91-416) also all contain plagioclase, perthite (microcline in CG84-319, CG91-004), quartz, biotite (orange-brown or bronzy), dark-green hornblende, an opaque oxide, apatite, and (sporadically) zircon and allanite. In addition, green clinopyroxene and slightly pleochroic orthopyroxene are present in CG07-012B and VN91-416.

Two of the associated mafic rocks were also examined in thin section. A sample of amphibolite/mafic granulite from the 3-km-long body within the granite (CG97-041) contains metamorphic orthopyroxene, and a sample from the lensoid mafic rock between the granite and the monzonite (VN91-424A) is a two-pyroxene, garnet-bearing metagabbro. Both samples have clearly experienced high-grade metamorphic conditions.

There are no stand-alone diagnostic features above that justify separation of these rocks from other granitoid units in the region. The chief criteria used are the rocks' overall homogeneity and lack of migmatization (which distinguishes them from the earlier gneisses), their 'charnockitic/mangeritic' aspect and mid- to late-Labradorian age (which identifies them with Labradorian AMCG suites in the region, *e.g.*, MMIS), and their strongly deformed character (which contrasts from the Upper Paradise River intrusive suite).