CHAPTER 8

PRE-LABRADORIAN GRANITOID ROCKS IN GRENVILLE PROVINCE (P_{3A} 1800–1710 Ma)

Granitoid rocks of this age in eastern Labrador belong to two groups. One is a series of discrete alkali-feldspar syenite bodies in the Makkovik Province that have already been addressed (*see* Section 6.5). The other is the Eagle River complex in the Grenville Province, which is the topic of this chapter.

8.1 EAGLE RIVER COMPLEX (P_{3A}gd, P_{3A}dr, P_{3A}gr, P_{3A}am)

The Eagle River complex is a newly coined name for a package of granitoid rocks located southeast of the Mealy Mountains intrusive suite in the Mealy Mountains terrane. As mapped, it underlies two adjacent areas, separated by a west-northwest-trending fault (Figure 8.1). The area on the north side is most confidently assigned to this group of rocks through supporting geochronological data, in contrast to the area on the south side, which is poorly known. For this reason, the two areas are addressed separately. Representative slabs of dated rocks are displayed in Appendix 2, Slab images 8.1).

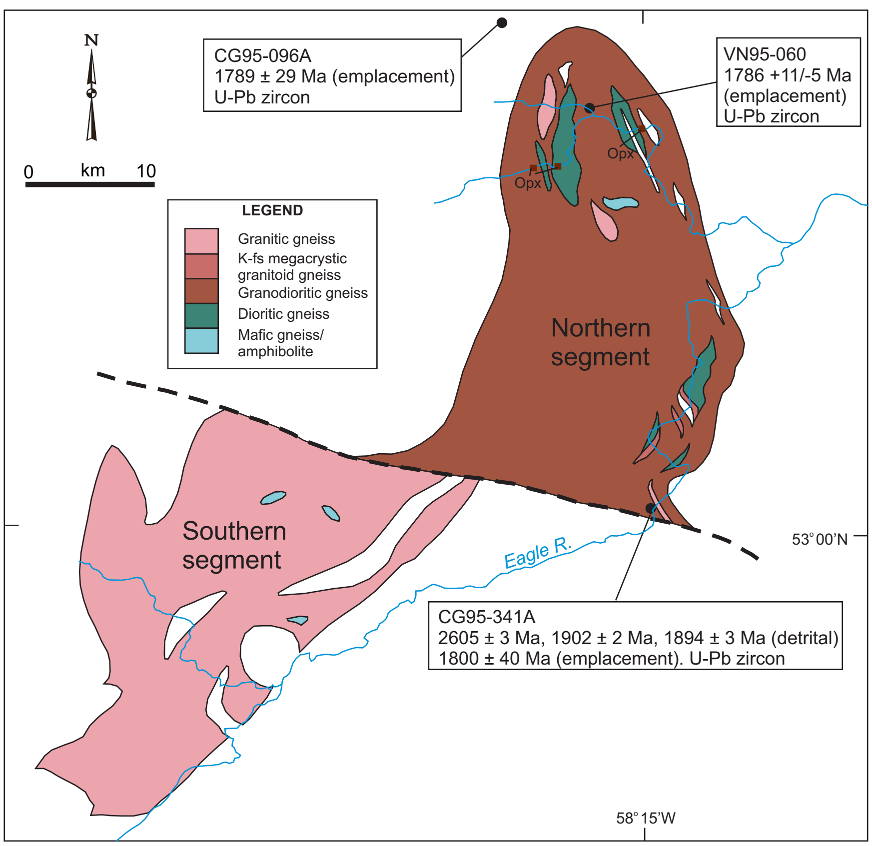

Figure 8.1. *Pre-Labradorian granitoid rocks in the Grenville Province assigned to the Eagle River complex.*

8.1.1 NORTHERN SEGMENT OF EAGLE RIVER COMPLEX

The northern part of the Eagle River complex was mapped by Gower and van Nostrand (1996) with follow-up geochronological studies by Gower *et al.* (2008b). The rocks are mainly biotite granodiorite gneiss to hornblende quartz diorite gneiss. This part of the complex is only exposed along river sections of Eagle River and one of its major tributaries. Areas flanking the river are wetlands lacking outcrop, hence the exact extent of the complex remains uncertain, being drawn on the basis of equivocally interpreted aeromagnetic patterns.

The age of the Eagle River complex relies on two U–Pb age determinations within the complex (but also supported by an additional date from the enderbitic granulite addressed at the end of Section 7.3.6.1; sample CG95-096A; Figures 7.1 and 8.1; Appendix 2, Slab images 8.1). The most conclusive result is from a well-banded granodioritic orthogneiss (VN95-060; Plate 8.1A). It yielded an age of 1786 +11/–5 Ma, based on two near-concordant multigrain zircon fractions and one slightly more discordant single zircon. The other determination is from a well-banded to mylonitic quartzofeldspathic orthogneiss inferred to contain assimilated material from a metasedimentary protolith (CG95-341A; Plate 8.1B). It has an age of 1800 ± 40 Ma, based on two near-concordant single zircons, interpreted to

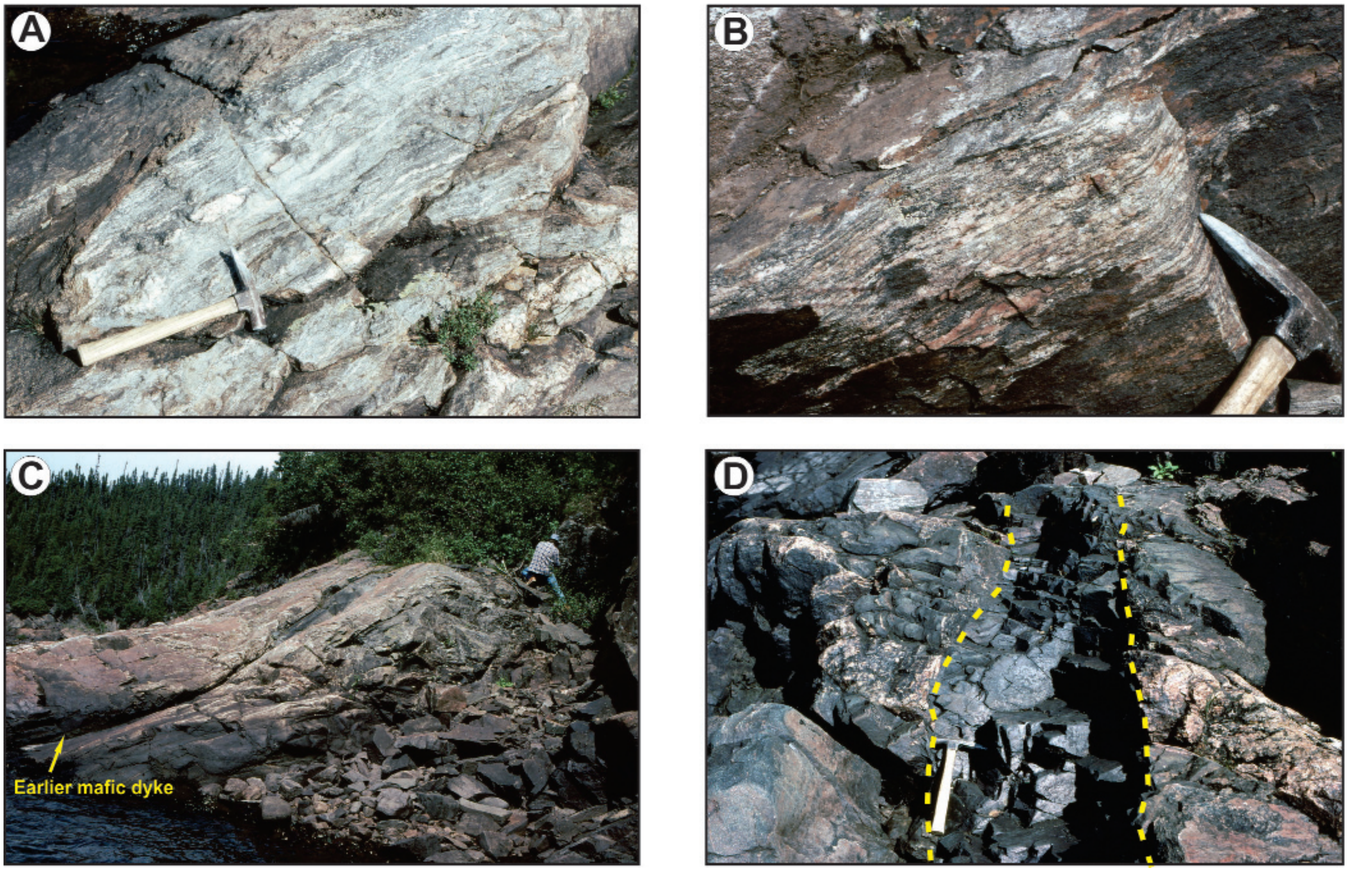

Plate 8.1. *Eagle River complex at two U–Pb geochronology sites. A. Granodiorite gneiss at northern U–Pb geochronology site (VN95-060), B. Granodiorite gneiss at southern U–Pb geochronology site (CG95-341), C. General view of granodiorite gneiss outcrop CG95-341, also showing some of older mafic dyke (upper right to lower left), D. Same outcrop as B and C, showing later discordant mafic dyke; margins outlined for clarity (CG95-341).*

date the time of emplacement. This date is revised from a published age of 1798 ± 240 Ma (Gower *et al.*, 2008b), after a re-evaluation of the data by S. Kamo (personal communication, 2010). Three other zircon analyses from this sample, having ^{207}Pb/^{206}Pb ages of 2605 ± 3 Ma (9.2% discordant), 1902 ± 2 Ma and 1894 ± 3 Ma (both less than 1.3% discordant), are interpreted to be detrital.

The two dated samples have also been subjected to Sm–Nd isotopic analysis, yielding values of T_{DM} = 1959 Ma and εNd (1.79 Ga) = +1.59 (VN95-060), and T_{DM} = 2154 Ma and εNd (1.80 Ga) = –0.67 (CG95-341A). The higher T_{DM} values and lower εNd values in CG95-341A (and in CG95-096A – *cf.* Section 7.3.6.1) are consistent with field and petrographic evidence for greater supracrustal contamination.

The bulk of the gneiss is white-, grey-, creamy-, or brownish-weathering, generally medium-grained, well-layered biotite granodiorite to, locally, granite. Layering is regular to irregular and defined by variations in grain size and mineral concentrations. Thick to thin leucosome layers are generally the coarsest grained and, in addition to quartz and feldspar, may contain hornblende, clinopyroxene or orthopyroxene. Garnet is uncommon in either the leucosome or the melanosome. Thin veneers of melanosome comprise feldspar with hornblende and/or biotite grading into broader layers of more homogeneous granitoid material. The latter probably represents the igneous protolith of the gneiss.

On the 1:100 000-scale map, associated diorite to quartz diorite gneiss is only shown as localized lenses where crossed on stream sections, but it is not difficult to argue that it might be much more extensive than depicted, given the dearth of outcrop away from the rivers. Apart from having a slightly different bulk composition, the rocks are similar to the granodioritic gneiss and are assumed to share a common history. Similar comments regarding distribution and parentage apply to K-feldspar augen orthogneiss. The augen are mostly small (2 x 1 cm), typically partially to completely recrystallized and found in rocks that have a separate leucosome component. Small lensoid areas and larger bodies designated as hornblende granite and monzonite are more homogeneous, but it remains unknown whether the homogeneity is due to the rocks having escaped the migmatization that affected the remaining gneisses, or whether they merely show less effect of it.

Amphibolite occurs as black-weathering, medium-grained, recrystallized lenses and boudinaged pods (assumed to represent deformed remnants of metamorphosed mafic dykes), mostly concordant to gneissosity and typically invaded by quartz-feldspar veins. Rare pods of ultramafic rocks and a few larger gabbroic bodies, up to 200 m wide, occur locally. These are also metamorphosed and injected by felsic veins.

Mafic dykes, still preserving discordance to gneissosity, were sporadically recorded. One, on the main tributary of the Eagle River, is a 10-cm-wide foliated amphibolite, which is crosscut by a 3-cm-wide pegmatite (CG95-062). At geochronology site CG95-341, quartzofeldspathic gneiss is intruded by two generations of mafic dykes. The earlier mafic dyke is a foliated, dark-grey to black, fine-grained amphibolite veined by pink aplite. The margins of the body are transposed and only equivocal hints of discordance to the country rock gneissosity are present (Plate 8.1C). There are no doubts about field relationships of the later mafic dyke. It is massive, dark-grey to black, fine-grained amphibolite, having straight, parallel-sided, discordant margins to the host gneiss and the earlier amphibolite (Plate 8.1D). In contrast to the earlier amphibolite, it is not intruded by aplite veins and it shows relict primary diabasic texture. The clear discordance, lack of aplite and preservation of primary textures in the massive amphibolite all argue in favour of it postdating the foliated amphibolite. The massive mafic amphibolite is interpreted to postdate the gneiss-forming event, in which the earlier amphibolite was embroiled. Note that this relationship is known from many other localities in eastern Labrador (*cf.* Schärer *et al.*, 1986; Schärer and Gower, 1988; Gower *et al.*, 1992).

Veins of both concordant and discordant pegmatite and aplite are common in the quartzofeldspathic gneiss. They are typically deformed and show boudinage or buckled form. Muscovite is present in a few pegmatites.

Samples examined petrographically from the quartzofeldspathic gneiss can be divided into two groups, based on the presence or absence of orthopyroxene, which was only seen in the northwesternmost samples.

Thin sectioned samples lacking orthopyroxene are CG95-018, CG95-028A, CG95-032, CG95-040, CG95-043, CG95-341A, VN95-029, VN95-032, VN95-037 and VN95-060. Quartz is anhedral and recrystallized, and, at the two southernmost sites, where deformation is strongest, it has elongate-to-ribbon form. Plagioclase is poor to well twinned, recrystallized and typically is moderately to heavily sericitized. K-feldspar is mostly well-twinned microcline. Biotite forms somewhat ragged, olive-green to orange-brown aligned flakes, which are extensively altered to chlorite in the two southernmost, extensively deformed rocks. Amphibole is present in CG95-028A, CG95-043 and VN95-032, forming anhedral, somewhat ragged grains containing quartz inclusions. Accessory minerals include an opaque oxide, allanite, zircon, apatite, and titanite, and secondary minerals are biotite, quartz, carbonate, chlorite, epidote and white mica. Zircon was noted as having cores and rims in some samples. In VN95-032, which contains a higher proportion of mafic minerals than the other orthogneisses, sparse, amoeboid, prograde garnets are present, as a product of amphibole and/or biotite breakdown. Clinopyroxene is present in CG95-032, which is a dioritic rock, rather than granodioritic like many of the other samples.

Two samples, despite lacking orthopyroxene, do not readily fit into the orthopyroxene-absent category (CG95-060, VN95-008A). Both are interpreted here as enclaves derived from a metasedimentary protolith. The localities are 21 km apart but line up with the regional structural trend, a few kilometres west of the inferred boundary between orthogneiss and metasedimentary gneiss. The two samples contain abundant, large subhedral garnets, although in CG95-060 much of it is pseudomorphed by green biotite, quartz, an opaque mineral and white mica. The host minerals are quartz, plagioclase, perthite/microcline, biotite (pale-green in VN95-008A and orange-brown in CG95-060), zircon and an opaque mineral. Hints in favour of metasedimentary parentage are: i) the presence of garnet is in contrast to the associated felsic orthogneiss, where garnet is neither common nor large, and ii) a pelitic gneiss enclave (VN95-010) and a gossanous zone (typical of metasedimentary gneiss) near VN95-008.

The orthopyroxene-bearing samples are CG95-062, VN95-053 and VN95-074; although in VN95-053 orthopyroxene is present only as chloritized pseudomorphs. Other minerals are polygonal quartz, poor- to well-twinned plagioclase, perthitic and microcline K-feldspar (not in CG95-062), orange-brown to red-brown biotite, an opaque oxide, apatite and zircon.

In metagabbro sample CG95-028B, plagioclase occurs as markedly zoned, well-twinned primary laths that have irregular, recrystallized grain boundaries surrounded by polygonal aggregates of small, poorly twinned recrystallized plagioclase. Clinopyroxene also occurs as pale green, relict, primary grains heavily dusted with exsolved opaque inclusions. Other primary minerals are an opaque oxide (also recrystallized) and apatite. Granular aggregates of orthopyroxene may indicate the former presence of olivine, formed by the reaction:

$$\textit{Olivine} = \textit{Orthopyroxene} + \textit{Quartz}$$

Relict primary clinopyroxene is enveloped in broad coronas made up of recrystallized hornblende, minor quartz and is suggested to have developed by a simple hydration reaction, whereby:

$$\textit{Clinopyroxene} + H_2O = \textit{Hornblende} + \textit{Quartz}$$

Both generations of mafic dyke at data station CG95-341 were examined petrographically. The earlier dyke (CG95-341B) is completely recrystallized and has a granoblastic texture. It consists of polygonized aggregates of anhedral, heavily sericitized plagioclase; blue-green, anhedral amphibole; orange-brown, aligned biotite; minor quartz and traces of an opaque oxide and sulphide. The later dyke (CG95-341C) contains elongate plagioclase laths that, in stained slab, show suggestions of quench texture. They are interpreted as primary, although exhibiting recrystallized borders in thin section. Smaller polygonal plagioclase grains form part of the groundmass mosaic. Other minerals are anhedral, green, polygonized amphibole grains; ragged, orange-brown biotite; an opaque mineral; secondary carbonate (in fractures) and fine-grained granular material that might be secondary titanite.

Pegmatitic infill between amphibolite boudins was also thin sectioned (CG95-341D). The mineral assemblage in the boudin infill comprises large, polygonized quartz grains, primary and polygonized plagioclase, orange-brown biotite, garnet, and zircon. Note that this sample was investigated geochronologically, yielding a Pinwarian age of 1496 ± 10 Ma, based on two almost concordant zircon tips and collinear monazite from the host quartzofeldspathic gneiss (Gower *et al.*, 2008b).

8.1.2 SOUTHERN SEGMENT OF EAGLE RIVER COMPLEX

Rocks assigned here to the southern segment of the Eagle River complex were mapped by Gower and van Nostrand (1996; north of 53°N) and Gower (1998; south of 53°N). In both reports, uncertainty was expressed regarding the likely affiliation of the rocks (doubts that time has not, so far, ameliorated). Difficulties in classifying the rocks are due to paucity of exposure, lithological variety displayed in the few outcrops that do exist, and lack of any serious follow-up investigation. On the 1:100 000-scale maps of Gower (2010a; Eagle River and Southeast Mealy Mountains map regions) most of the complex is depicted as underlain by Unit P_{3A}gr (granite), with which Unit P_{3A}ag (mafic to mafelsic granulite) and units P_{3B}gd, P_{3B}gp, P_{3B}mq (granodiorite, K-feldspar megacrystic granitoid rocks, and quartz monzonite, respectively) are associated. Implied, therefore, is that both pre-Labradorian (*ca.* 1800–1710 Ma) and early Labradorian (*ca.* 1710–1660 Ma) rocks are present. The P_{3A} or P_{3B} designations are no more than experience-based guesses, although the rocks are likely to fall into one or other category.

The rocks are pink-, buff-, orange-brown-, white-, grey- or creamy-weathering, medium to coarse grained, weakly to strongly foliated, recrystallized, mostly homogeneous or indistinctly banded. In the field, the outcrops were labelled variously as quartz syenite, quartz monzonite, granite and alkali-feldspar granite, but stained slabs display less compositional variability. Also present are rare, diffuse mafic enclaves and irregular pegmatitic patches, as well as later discordant pegmatite.

Granitoid rocks examined in thin section are as follows; P_{3A}gr – CG95-318, CG97-014 and CG97-050; P3Bgp – CG95-342; P_{3B}mq – CG95-304, CG95-305 and CG97-032. All contain relict igneous or metamorphic plagioclase, K-feldspar (mostly perthite), quartz (minor in CG97-014), orange-brown biotite (except CG97-032, CG97-050), dark-green hornblende (except CG97-014), an opaque oxide, apatite and zircon. The K-feldspar megacrysts in CG95-342 measure 2 x 1 cm. Clinopyroxene is present in CG97-032 and CG95-304, and inverted pigeonite is found in all samples, except CG97-014 and CG95-342. Relict orthopyroxene, mostly altered to bastite, occurs in CG97-050. Allanite is sporadically seen, but not common, although some of the grains are unusually large. The presence of pigeonite, in particular, suggests linkage with the Mealy Mountains intrusive suite.

The associated mafic to mafelsic granulite was mapped at three sites, one of which had been previously indicated by Eade (1962) on his map. This rock was termed granular-textured dioritic gneiss by Gower and van Nostrand (1996).

A thin section from one site (CG95-307) contains antiperthitic plagioclase, weakly or non-pleochroic orthopyroxene, pale-green clinopyroxene, hornblende, dark-orange-brown biotite, an opaque oxide, apatite, zircon and traces of allanite.

Gower and van Nostrand (1996) and Gower (1998) suggested that the rocks either predate the emplacement of the Mealy Mountains intrusive suite or are an early phase of it. In favour of a pre-MMIS age are the following tenuous lines of evidence: i) the area is one of low relief, poor exposure and abundant wetlands – features that are more characteristic of pre-MMIS granitoid and gneissic rocks than the erosion-resistant MMIS, ii) the rocks are compositionally varied, well foliated and locally diffusely gneissic, whereas MMIS bodies tend to be uniform and massive or weakly foliated, iii) field notes made at the time made the specific observation that these rocks contrast with those of the MMIS. Lines of evidence supporting correlation with the MMIS are: i) simpler regional interpretation, and ii) several of the rocks have petrographic features typical of the MMIS, such as inverted pigeonite and abundant flame mesopethite.