

## GEOLOGY OF THE UPPER ST. AUGUSTIN RIVER MAP REGION, GRENVILLE PROVINCE, EASTERN LABRADOR

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### ABSTRACT

*The Upper St. Augustin River map region comprises 1:50 000-scale NTS map areas 13B/03, 13B/04, 13B/05, and 13B/06. The area is topographically dominated by the St. Augustin River and its tributaries, which are incised in the south, creating varied relief and moderately good exposure. Exposure is further enhanced by bygone fires that have removed forest cover across much of NTS map areas 13B/03 and 13B/04. In the north, the area is poorly exposed and consists of low spruce-covered hills interspersed with wetland clearings and shallow lakes.*

*Rocks in the map area are classified into seven groups, namely, i) metasedimentary gneiss, ii) foliated to gneissic granitoid and associated rock types, iii) metamorphosed mafic intrusions, layered in places, iv) a satellite pluton of the Mealy Mountains Intrusive Suite, v) metadiabase, vi) K-feldspar megacrystic granodiorite to quartz monzonite, and vii) late- to post-Grenvillian plutons.*

*The metasedimentary gneisses are probably among the oldest rocks present. Sillimanite-bearing metasedimentary gneiss was discovered near the central-west margin and north of the centre of the map region. Most of the metasedimentary gneiss is quartz-rich and mapped as quartzite or psammitic gneiss, but a few associated occurrences of 'tonalitic' rocks could be of supracrustal origin.*

*The well-banded gneiss and foliated granitoid rocks show a continuum of fabrics suggesting that both are derived from a common igneous plutonic protolith. The rocks are overwhelmingly granitic, but some granodioritic gneiss and minor diorite, monzodiorite, quartz monzodiorite also occur. K-feldspar megacrystic granodiorite, in which the megacrysts are preserved only as recrystallized aggregates, is associated with the same package of rocks. A close spatial association exists between the granodioritic and metasedimentary gneiss, and K-feldspar megacrystic granodiorite, leading to the thesis that rocks mapped as granodioritic gneiss may have a supracrustal protolith, in part, and that a genetic link also exists with the K-feldspar megacrystic rocks.*

*Metamorphosed gabbro, leucogabbro and monzogabbro occur in the northwest corner of the map region and represent the continuation of a mafic intrusion previously mapped to the north and west. Metamorphosed mafic rocks were discovered in the southwest corner, but their affiliation remains uncertain (possibly linked to the Petit Mecatina suite). Minor amphibolite is found throughout the mapped region with the foliated and gneissic granitoid rocks and probably represents the remnants of mafic dykes.*

*The pluton grouped as part of the Mealy Mountains Intrusive Suite (MMIS) has a syenite to monzonite composition. In addition to compositional and petrographic criteria, it is assigned to this group because it occurs in a similar tectonic setting to other satellite plutons east and south of the MMIS.*

*The metadiabase rock group is represented by one outcrop in the southeast corner of the mapped region. The rock is texturally distinct from the metamorphosed rocks previously described, and is regarded as probably genetically distinct.*

*Foliated to massive, K-feldspar megacrystic granodiorite to quartz monzonite was mapped along the eastern boundary of the mapped area, being a continuation of a unit previously mapped farther east. Its age has not been determined and it is not correlated with the K-feldspar megacrystic granodiorite previously described. Lack of migmatization suggests that it might be as young as syn-Grenvillian.*

Several massive, unrecrystallized, monzonite to alkali-feldspar granite plutons were mapped. These were only previously suspected from positive magnetic anomalies. These intrusions are included as part of a suite of late- to post-Grenvillian plutons, already known to be widespread throughout southern Labrador.

The structural grain is east to northeast over most of the region, and is interpreted to be linked to the west flank of a major northeast-trending fold, having its axial trace passing through the southeast section of the mapped region. A north-west-trending foliation is interpreted to be younger. Metamorphic grade is at amphibolite facies. A northwest-trending fault possibly passes through the northern part of the region, linking up with linear magnetic features to the southeast and a fault to the northwest. The fault is parallel to late, brittle fractures outside the region. None of these structures appear to disrupt regional geological patterns.

No mineral occurrences were found, but a magnetite-rich pegmatite was recorded near the eastern (central) margin of the region and a pyrite-filled minor fracture was noted in a mafic rock in the southwest corner. Biotite sheets, over 20 cm across, were previously recorded from the southwest corner. One magnetic and two lake-sediment geochemical targets of secondary merit exist.

## INTRODUCTION

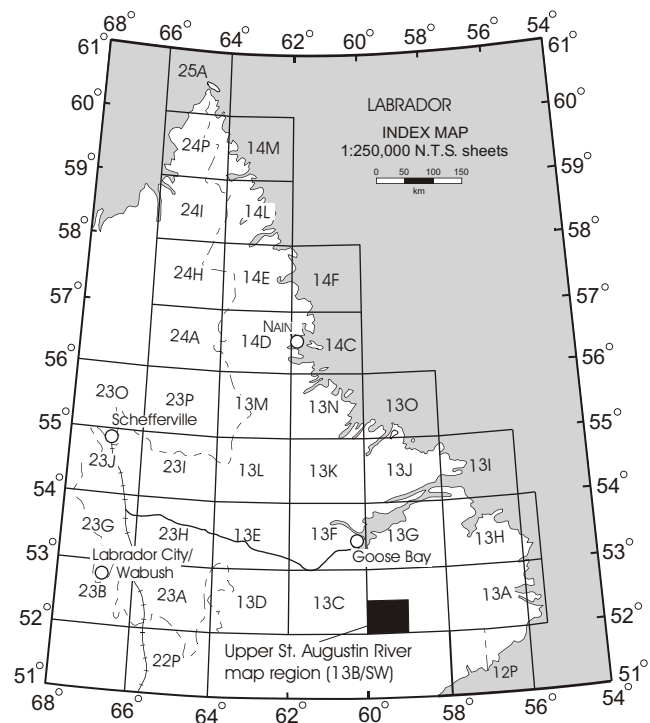
### LOCATION AND MAPPING SCHEDULE

The Upper St. Augustin River map region is located in southern Labrador, 90 km from Goose Bay at its northwest corner and 170 km from Goose Bay at its southeast corner. Its southern boundary is coincident with the Labrador – Quebec border (Figure 1). The region includes 1:50 000-scale NTS map areas 13B/03, 13B/04, 13B/05, and 13B/06 (13B/southwest), collectively embracing an area of about 3700 km<sup>2</sup>. Mapping in the region was carried out between June 7th and July 12th, 2000, as part of the continuing program of geological reconnaissance mapping in Labrador by the Newfoundland Department of Mines and Energy. In particular, this study forms the last stage of a 4-year project to map NTS map area 13B at 1:100 000 scale (*cf.* Gower, 1998, 1999, 2000 for related reports). After completion of the 2000 mapping program (including the mapping of James and Nadeau, *this volume*), only two of the fifty 1:100 000-scale map regions in the Labrador part of the Grenville Province, now remain incompletely mapped.

### TOPOGRAPHY AND OUTCROP

The region topographically belongs to a dissected plateau that extends throughout much of interior southeast Labrador. The highest elevations are in the northeast third of the area, where much of the terrain is over 500 m, reaching 576 m at one hilltop in the northeast corner. General elevation decreases from about 550 m in the northeast to 350 m in the southwest.

The controlling topographic feature is the south-flowing St. Augustin River, and much of the region is within the upper part of the St. Augustin River drainage basin, except the western part, which belongs to the Joir River and is a



**Figure 1.** Location of the Upper St. Augustin River map region (NTS 13B/southwest) in Labrador.

tributary of the Little Mecatina River. Both the St. Augustin and Little Mecatina rivers discharge into the Gulf of St. Lawrence.

The northern part of the St. Augustin River in the map region is contained within a shallow V-shaped valley, on the flanks of which sporadic exposures may be found, but very few along the river banks. Farther south, the river is incised into a 200-m-deep, 10-km-long gorge, along which there are numerous rapids and small waterfalls. Exposure is excellent here, but is generally inaccessible by either watercraft or air-

craft. The simplest means to access the exposures is to climb down the flanks of the gorge. On turning from south-, to southeast-flowing for the final few kilometres, the river opens out to a U-shaped valley having a 2-km-wide floor blanketed by sand and gravel deposits (Plate 1) and bedrock exposure only on the shoulders of the valley. Tributaries of the St. Augustin River, particularly the Matse and Michaels rivers to the west, and the lower parts of two unnamed tributaries to the east, are also incised, sufficiently so to provide common outcrops of bedrock, both in the rivers and on the valley walls. Exposure along the Joir River, or within its shallow valley on either side is sparse, except for a 5-km-long section near the western margin of the map region.



**Plate 1.** *St. Augustin River near the southern boundary of the map region; looking southeast.*

Regions between the Joir and St. Augustin rivers and their major tributaries are characterized by small, shallow lakes and ponds, string bogs and marshlands, interspersed with spruce-covered low rises or rounded, wooded hills. Exposure occurs in a variety of settings, including tops of hills, on their steeper slopes and adjacent to marshes, but is generally poor, being mostly lichen- and moss-covered. A major contrast exists in exposure between the north and south halves of the map region due to bygone fires that have destroyed most of the forest cover in the south, especially in NTS map areas 13B/03, eastern 13B/04, southwestern 13B/05 and southernmost 13B/06. In 13B/03 and 13B/04, the fires occurred long ago and vegetation regeneration has resulted in sparsely to moderately treed, caribou-moss uplands, in which outcrops (although not abundant) are relatively easy to spot and gain access to using a helicopter. The areas of more recent fires have dead trees still standing, reducing helicopter access in places but making any exposure present easy to spot, and providing some assurance regarding true outcrop density. In the more heavily forested areas in the north this assurance is not available, but it seems unlikely that more detailed work would result in significant outcrop database improvements. Access to most outcrops in the wooded areas can be gained by short walks from the nearest clearing. Only in a few instances was it necessary to walk more than 200 to 300 m, but even a 500 m traverse to an outcrop in this region is very time-consuming, impeded as it is by thick undergrowth, abundant dead fall and uneven, moss-covered ground. Of the sixteen 1:50 000 map regions comprising NTS sheet 13B, only in 13B/03 and 13B/04 would daily ground traversing have been worthwhile.

Topography and vegetation are less helpful guides to underlying bedrock in this map region than its neighbours to the north and east, allowing no more than a two-fold division between, i) orthogneiss, metasedimentary gneiss, foliated granitoid units and a few metamorphosed mafic rocks, and ii) late- to post-Grenvillian plutons. The gneisses and foliated granitoid rocks, which underlie most of the region, may be found indiscriminately in wetlands, spruce-covered rises and hills and in river valleys. In previously mapped adjacent regions, late- to post-Grenvillian plutons are typically characterized by heavily forested, steep-sided hills (or rock cliffs) capped by craggy outcrops. Such a tendency is still evident in the St. Augustin map region, but is much less obvious, and an inadequate discrimination criterion to use alone in delineating pluton boundaries.

Mapping was carried out entirely by helicopter, except for some brief foot traverses along short segments of some rivers. In total, 382 data stations have been established in the map region, a comparable rate of data acquisition to that achieved in 1999 during mapping of the upper St. Paul River map region (Gower, 2000), and somewhat higher than that in 1997 and 1998 during mapping of the less well-exposed Upper Eagle River and Crooks Lake map regions (Gower, 1998, 1999). The map of Eade (1962) shows 10 structural observations from this area. It is worth bearing in mind that most outcrops were but briefly examined. Given that many outcrops are heterogeneous gneisses and that few outcrops were investigated in detail, it is quite conceivable that another mapper would gain a somewhat different impression of rock types present.

Samples were collected from all but one data stations, slabbed and then stained to assist in the identification of potassium-bearing minerals, as well as more effective examination of textures. Samples have also been submitted for petrographic, geochemical and geochronological analysis.

## PREVIOUS WORK

The only previous published non-derivative geological map that includes the region, is the 1:506 880-scale map of Eade (1962). Eade's map shows the northwestern 20 percent of the St. Augustin map region as unmapped, and, for the remainder of the area, its cursory nature provides no more than a hint of the fundamental contrast between metamorphosed and unmetamorphosed granitoid rocks now known to exist.

Geological mapping at 1:100 000 scale has been completed to the west (James and Nadeau, 2000), northwest (James and Lawlor, 1999), north (Gower, 1999), northeast (Gower, 1998) and east (Gower, 2000). The southwest, south and southeast regions (in Quebec) are included in the 1:250 000 compilation maps of Avramtchev (1983a, b) for NTS sheets 12N and 12O. Aeromagnetic coverage of the region is available at 1:63 360 scale (Geological Survey of Canada, 1971a, b, c, d) and 1:250 000 scale (Geological Survey of Canada, 1976) as uncoloured maps, and as a coloured magnetic anomaly map at 1:1 000 000 scale (Geological Survey of Canada, 1985). Shaded-relief coloured aeromagnetic maps based on the Geological Survey of Canada data are available at 1:250 000 and 1:100 000 scale from the Newfoundland Department of Mines and Energy. The study area is also included as part of the 1:500 000-Bouguer anomaly map for Battle Harbour – Cartwright (Thomas, 1974), a regional lake-sediment and geochemical survey for NTS map area 13B (Friske *et al.*, 1994) and a regional surficial deposits study of southern Labrador (Fulton *et al.*, 1975). As a result of the 1977 Canada-Newfoundland Uranium Reconnaissance Program, an area that included the southwestern part of NTS map area 13B/03 and southeastern part of 13B/04 was selected for detailed lake-sediment geochemical follow-up studies (McConnell, 1978, 1979). Some anomalous metal values were found and are mentioned in the section entitled 'Economic Potential'.

## REGIONAL GEOLOGICAL SETTING

The study area is situated in the Mealy Mountains and/or Pinware terranes (the boundary between the two being undefined in this region) within the Grenville Province in eastern Labrador and belongs to the Interior Magmatic Belt of Gower *et al.* (1991) (Figure 2). The rocks are believed to be late Paleoproterozoic and Mesoproterozoic, based on age extrapolations from outside the mapped

region. A geological map of the region is presented as Figure 3 and a shaded-relief aeromagnetic map, from which geological boundaries are partly interpreted, as Figure 4.

In broadest terms, rocks within the map region can be divided into seven groups, namely, i) metasedimentary gneiss, ii) foliated to gneissic granitoid and associated rock types, iii) metamorphosed mafic intrusions, layered in places, iv) a satellite pluton of the Mealy Mountains Intrusive Suite, v) metadiabase, vi) K-feldspar megacrystic granodiorite to quartz monzonite, and vii) late- to post-Grenvillian plutons.

## DESCRIPTION OF MAP UNITS

### METASEDIMENTARY GNEISS

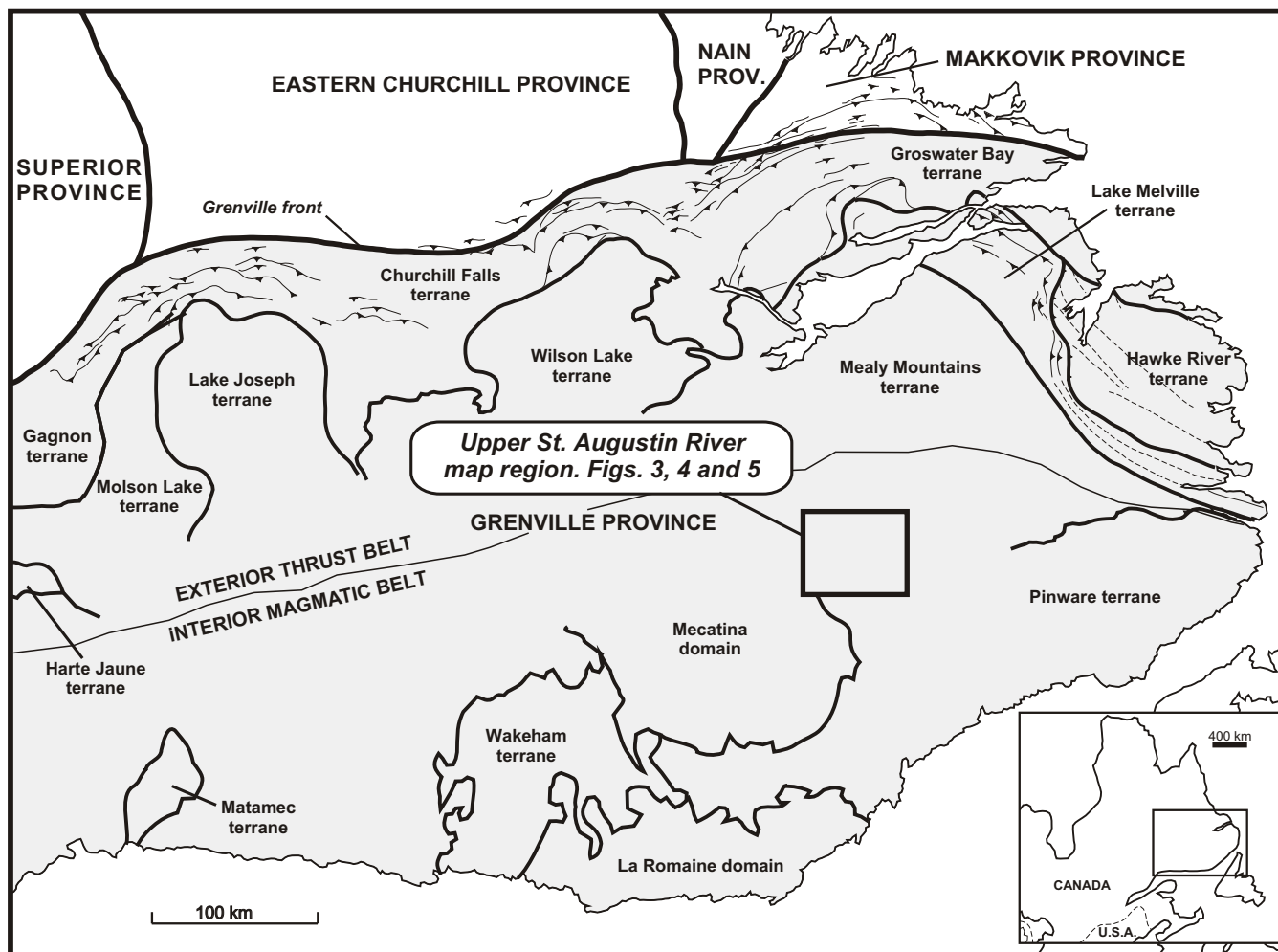
#### Sillimanite–Biotite Pelitic Gneiss

Two outcrops of sillimanite–biotite pelitic gneiss were found within the map region. One is near the western margin and consists of extensive, coarse-grained, pink-weathering leucosome interspersed with irregular patches and lenses of black-weathering biotite-rich melanosome. Sillimanite occurs in clusters within the melanosome as white-weathering veneers and lenses, in which individual sillimanite needles are up to 1 cm long. Minor zoisite was identified in thin section. The other outcrop occurs north of the centre of the map region. The sillimanite is concentrated in white layers up to 3 cm thick flanked by granitic leucosome. Sillimanite also occurs interspersed with feldspar–biotite material where it appears to be the product of less complete segregation during melting. Corundum, seemingly posttectonic, was seen in thin section.

#### Quartzite and Psammite

The discovery of quartzite and psammitic gneiss perhaps represents the most noteworthy addition to the geological knowledge of the region, as such rocks were completely unknown prior to mapping. The rocks are concentrated in the south and southeast and presumably continue south of the Quebec–Labrador border, although not indicated on any geological maps for the areas concerned.

In their present metamorphic state, the psammitic gneisses are not easy to distinguish from some of the closely associated foliated and gneissic granitoid rocks. The most diagnostic criterion is the presence of banded quartzite, which is commonly interlayered with the psammitic gneiss, but, generally, one must rely on more subtle features. In contrast to the pink-weathering granites, the psammitic gneisses are normally pale grey-weathering, but with creamy and white variants; only rarely do they take on hues of pink.

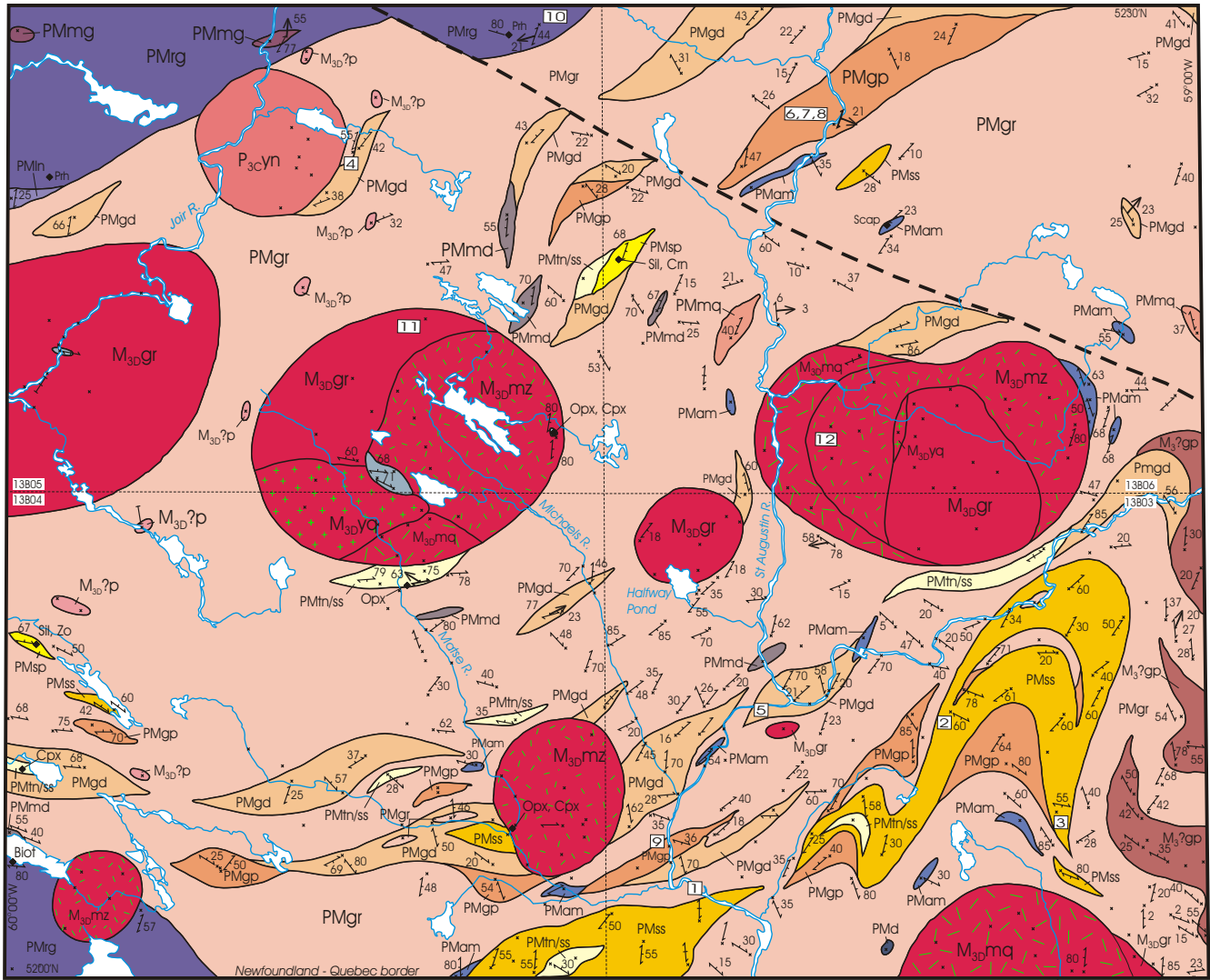


**Figure 2.** Tectonic context of the Upper St. Augustin River map region in the eastern Grenville Province.

Also, the psammitic gneisses are generally finer grained than most of the granitoid rocks, the latter which, even in a polygonized, recrystallized state, still commonly retain vestiges of their former coarser primary textures. The psammitic gneisses are also more continuously and evenly banded than the lensey fabrics of the granitic orthogneisses. In places they are finely laminated and have narrow biotitic partings, although no interlayered aluminosilicate-mineral-bearing pelitic material was found. Very narrow black seams may be heavy mineral laminations (Plate 2). Some of the layers are sufficiently uniform to accept them as primary bedding features. Outcrops of psammitic gneiss are rare that do not show some associated granitic material (Plate 3). The granite commonly contains rafts of quartzite or quartz-rich psammitic rock and invades the psammitic gneiss in an irregular, anastomosing, but mostly concordant manner. That it is probably locally derived is suggested by the anomalously quartz-rich nature when compared to typical granite, and it is associated with quartz-rich pegmatites and quartz veins. Later, discordant microgranite and pegmatite dykes are present in some localities.

In addition, a few outcrops of similar rocks were mapped roughly parallel to, but about 30 km northwest of the more-or-less continuous belt of quartzite and psammitic gneiss in the south. Together with the two occurrences of sillimanite-biotite pelitic gneiss previously described and one each in the Crooks Lake and Upper St. Paul River map regions (Gower, 1999, 2000), these may constitute remnants of a separate zone of metasedimentary gneisses. An isolated outcrop of grey-weathering, medium-grained, recrystallized quartzite was mapped in the northeast part of the map region. A stained slab confirms that the rock is composed of 90 to 95 percent quartz. Variations in the proportions of minor interstitial K-feldspar, even less plagioclase and rare biotite are responsible for the subtle banding that is evident.

The age of the quartzite and psammitic gneiss is unknown, but some exclusions and possible correlations can be hazarded. At the outset, it seems unlikely that these rocks correlate with the vast areas of high-grade pelitic gneiss present farther north in the eastern Grenville Province, which are known to be pre-ca. 1700 Ma. This assertion is



LEGEND

MESOPROTEROZOIC

Late- to post-Grenvillian granitic rocks

- M<sub>30</sub>?p Pegmatite and microgranite
- M<sub>30</sub>Gr Granite
- M<sub>30</sub>Yq Quartz syenite
- M<sub>30</sub>mq Quartz monzonite
- M<sub>30</sub>mz Monzonite
- M<sub>30</sub>e Enclaves in late- to post-Grenvillian plutons
- Syn-Grenvillian or older
- M<sub>30</sub>?gp K-feldspar megacrystic granodiorite to quartz monzonite

MESO- AND PALEOPROTEROZOIC?

- PMd Metadiabase
- Mealy Mountains Intrusive Suite
- P<sub>30</sub>Yn Monzonite to syenite
- Metamorphosed mafic rocks
- PMmg Monzogabbro
- PMIn Metaleucogabbro
- PMrg Metagabbro, amphibolite
- PMam Amphibolite

MESO- AND PALEOPROTEROZOIC?

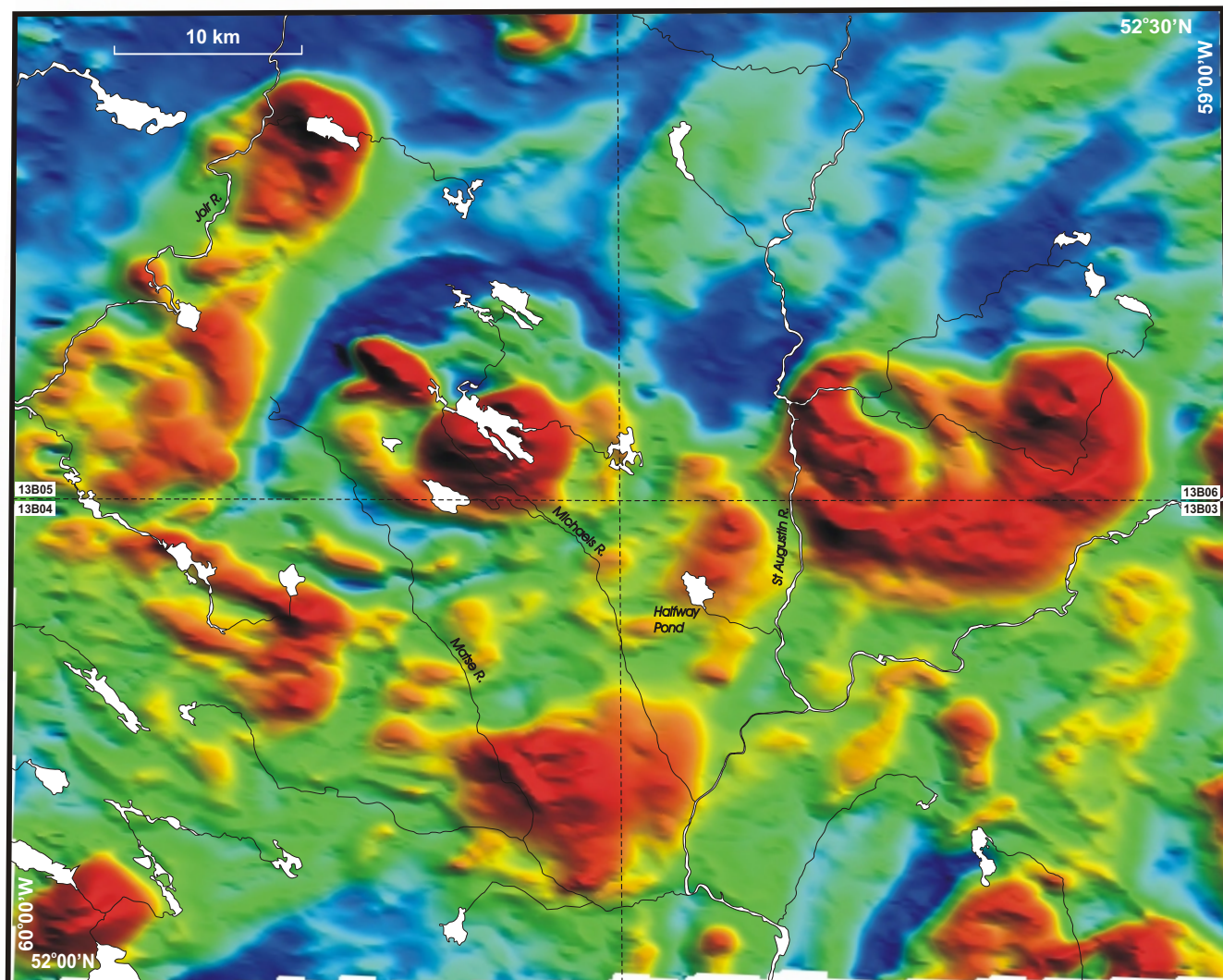
Foliated to gneissic granitoid rocks

- PMmq Quartz monzodiorite
- PMmd Diorite, monzodiorite
- PMgp K-feldspar megacrystic granodiorite
- PMgd Foliated granodiorite and granodioritic gneiss
- PMgr Foliated granite and granitic gneiss
- Metasedimentary gneiss
- PMtrn/ss "Tonalitic" gneiss, possibly of supracrustal origin
- PMss Psammitic gneiss and quartzite
- PMsp Sillimanite-biotite pelitic gneiss

SYMBOLS

- Data station
- ➔ Lineation
- Biot Biotite
- Opx Orthopyroxene
- Pth Prehnite
- ↗ Foliation, gneissosity
- ⊥ Igneous layering
- Scap Scapolite
- Cpx Clinopyroxene
- ↖ Enclave orientation
- Fault (speculative)
- Photographic site (Plate 1)
- 10 km

**Figure 3.** Geological map of the Upper St. Augustin River region. The boundaries of units have been interpreted from out-crop, topographic and aeromagnetic (cf. Figure 4) data.



**Figure 4.** Coloured shaded-relief aeromagnetic map of NTS map area 13B/southwest. Red end of spectrum – magnetic highs; blue end of spectrum magnetic lows; map prepared by G. Kilfoil.

based on the contrasting lithological nature and metamorphic grade of the two packages of rocks (although it is acknowledged that such differences could be explained by sedimentary and metamorphic facies variations). On lithological and metamorphic grounds, a more obvious correlation is with the Wakeham Group about 200 km to the southwest, and now known to have a pre-1500 Ma age, at least, in part. Although the large distance makes such a correlation tenuous, it must be remembered that there are areas of unnamed metasedimentary gneiss between the Wakeham Group and the Upper St. Augustin River map region that could also be related. Another (or equivalent) correlation could be with supracrustal rocks in the Red Bay area in the eastern Pinware terrane (Gower *et al.*, 1994). These are mostly quartzofeldspathic and include some quartzite, although much of it is suspected to be of volcanic/volcanoclastic origin. The age of the rocks is constrained to

between 1637 and 1490 Ma (cf. Wasteneys *et al.*, 1997; Tucker and Gower, 1994).

#### **‘Tonalite’ Gneiss of possible Supracrustal Origin**

A group of pale pink-, grey-, white-, or pale buff-coloured, medium-grained, recrystallized, generally well-banded, quartzofeldspathic gneisses have been assigned to their own separate group subsequent to mapping (based on stained slabs and petrographic examination). The preference here is to interpret them as having a sedimentary protolith, although the balance of evidence is very marginal. Their defining characteristic is that they all lack K-feldspar, except in rare concordant veins that can readily be interpreted as subsequent injected material. In the field, they were either assigned as K-poor members of the granodioritic gneiss unit, or as K-poor psammitic gneiss. The banding, which is



**Plate 2.** Quartzite showing dark partings, possibly enriched in biotite and/or heavy minerals and defining original bedding.



**Plate 3.** An example of equivocal protolith identification in the map region. The fine-grained sugary-looking material is interpreted to be psammitic gneiss and the coarse-grained layers to be granitic melt.

commonly unusually even and continuous, is due to grain-size contrasts, biotite-rich schlieren or veneers and plagioclase-rich leucogranite veins. Specific minerals that may provide clues to the protolith are orthopyroxene in one rock, which may indicate a ferruginous quartzofeldspathic sediment; and clinopyroxene and epidote in another, which hint at a calc-arenite protolith. It should be noted that the pres-

ence of pyroxene is not the product of granulite-facies metamorphism (see 'Metamorphism').

## FOLIATED TO GNEISSIC GRANITOID ROCKS

### Foliated Granite and Granitic Gneiss

Although overwhelmingly granite, the composition of this group of rocks includes minor alkali-feldspar granite and quartz syenite. The rocks weather to shades of pink, pale grey, orange, buff, creamy or, locally, purple or red, but most commonly have a streaky pink and white appearance (Plate 4). They are typically medium to coarse grained and recrystallized, and show evidence of having been polygonized from rocks having coarse-grained, primary, igneous textures. Foliations are typically moderate to strong, but include weakly foliated and gneissic fabrics. The overall appearance of the rocks ranges from homogeneous to moderately heterogeneous, having heterogeneity introduced by biotitic schlieren; quartzofeldspathic leucosome lenses, segregations and pods; amphibolite boudins and/or enclaves; xenoliths of granodioritic or psammitic gneiss; and concordant or anastomosing pegmatite and microgranite layers. Biotite is the usual mafic mineral, but minor hornblende is commonly present. The rocks are also intruded discordantly by sporadic microgranite and pegmatite dykes. Stained slabs from adjacent data stations, or small groups of stations commonly hint at mutual textural similarity, but different from nearby groups (e.g., most of the rocks having a more syenitic aspect are in the southeast corner of the map region). This variation is taken as tentative evidence for the presence of discrete granitoid bodies, although not adequately delineated so as

to justify cartographic discrimination.

The age of the foliated granite to granitic gneiss is not known. Field relationships indicate that at least some of it postdates granodioritic or psammitic gneiss and the rocks clearly were affected by deformation and metamorphism not experienced by the late- to post-Grenvillian plutons. If the



rocks are partly the product of partial melting of the metasedimentary gneisses and if the latter correlate with the post-Labradorian Wakeham Group, then a Pinwarian (1510 to 1450 Ma) age seems most likely, especially for those in the south. If a monzonite to syenite body described later is, indeed, a satellite intrusion of the mid- to late Mealy Mountains Intrusive Suite as suggested, then, clearly, the surrounding gneisses must be earlier.

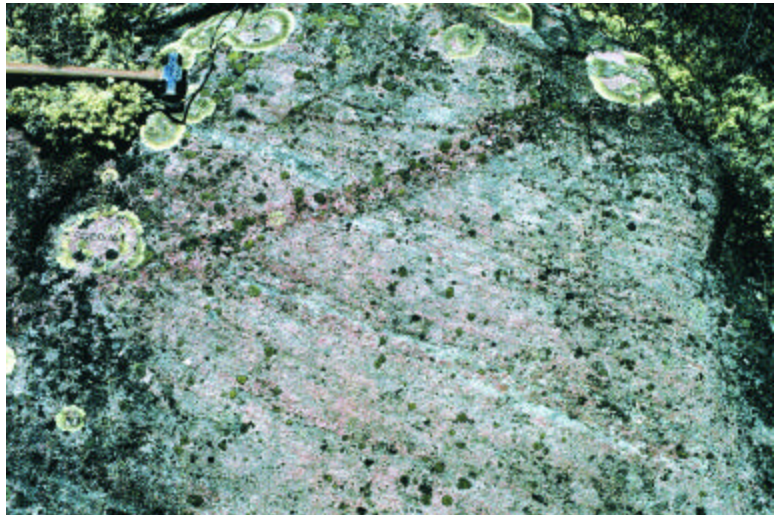
### Foliated Granodiorite and Granodioritic Gneiss

Rocks included in the unit are mostly well-banded gneisses, but include some diffusely banded or foliated rocks. The compositions, although dominantly granodiorite, include some very minor tonalite, quartz diorite and quartz monzodiorite. The rocks are grey-, creamy- and pink-weathering, medium to coarse grained and recrystallized. The well-banded appearance is due to pink or white leucosome layers, melanocratic bands, more subtle biotite- and feldspar-rich layers and, locally, amphibolite lenses and layers (Plate 5). The banded appearance is further emphasized by broader concordant pegmatite layers. Biotite is the normal mafic mineral, but hornblende is also commonly present. Some rocks are slightly anomalously quartz rich and could be contenders for a psammitic protolith (*see below*). The main differences between the granitic and granodioritic foliated and gneissic rocks are the dominantly grey-weathering colours in the granodioritic rocks versus pink in the granites (reflecting K-feldspar content), and the quality of banding, which is generally much better in the granodioritic gneisses. The rocks are discordantly intruded by microgranite and pegmatite dykes.

### K-feldspar Megacrystic Granodiorite

Two visually distinct types of K-feldspar megacrystic granitoid rock were found in the map region. One is described here, and the other, which may be genetically distinct, is described later under the name 'K-feldspar megacrystic granodiorite to quartz monzonite'.

The rocks included here are grey- pink-, creamy- or white-weathering, medium-grained, recrystallized from a coarser grained rock, and typically fairly homogeneous and moderately to strongly foliated, but range from weakly foliated to somewhat gneissic. Biotite is the dominant mafic mineral. Recrystallized aggregates of K-feldspar, up to



**Plate 4.** Typical, poorly banded, streaky-textured foliated granite to granitic gneiss. Intruded by minor pegmatite vein.



**Plate 5.** Well-banded granodioritic gneiss with concordant amphibolite layer.

about 2 cm in diameter, can be normally readily accepted as former megacrysts, although some have rather ragged outlines. Accepting some streaked-out aggregates as former megacrysts perhaps requires inferred deformational stretching to be matched by that of the imagination! In some rocks, the K-feldspar aggregates are sparse and/or show gradation down to matrix grain size. The latter are interpreted as former seriate-textured rocks.

Sporadically present are concordant and discordant microgranite and pegmatite dykes, enclaves of amphibolite or quartzofeldspathic gneiss. Some specific areas of K-feldspar megacrystic rocks considered deserving of additional description are addressed below.



**Plate 6.** Grey granodiorite interlayered concordantly with granitic material and discordantly intruded by pegmatite. Geochronology site.

A tongue of K-feldspar megacrystic granodiorite is depicted as extending from the northeast corner of the map region. The impression received is that the original rock was only ever sparsely megacrystic (Plates 6 and 7). It is mostly homogeneous, but in an outcrop on the St. Augustin River, the megacrystic rock forms a broadly banded gneiss due to alternation with concordant pegmatite and amphibolite (Plate 8). The pegmatites are generally less than 20 cm wide and have biotite-rich selvages suggesting local derivation from the enveloping host granodiorite. The amphibolite is black-weathering and medium grained and contains white-weathering tonalitic to K-feldspar-poor granodioritic pegmatite, that forms irregular, but, broadly, also concordant layers. The amphibolite is assumed to be derived from a mafic dyke emplaced into the K-feldspar megacrystic granodiorite, and the white-weathering pegmatite to be segregations developed from it during metamorphism. The host granodiorite, amphibolite and tonalitic pegmatite were sampled for U–Pb geochronological studies.

A second outcrop of megacrystic granodiorite was also sampled for geochronological studies, and is situated farther south on the St. Augustin River. Here, the rock is moderately to strongly foliated and contains abundant K-feldspar megacrysts up to 2 by 0.75 cm. Its interest centres on elongate enclaves of quartzofeldspathic gneiss up to about 4 m long and 1 m wide that are oriented parallel to the foliation in the megacrystic granodiorite (Plate 9). The foliation in the megacrystic granodiorite is, in turn, discordantly truncated by pink, fine- to medium-grained microgranite. The protolith of the quartzofeldspathic gneiss is uncertain (granodioritic or psammitic gneiss – *see discussion below*). Samples

of the gneiss, megacrystic granodiorite and microgranite were collected for U–Pb dating which, in addition to dating the three rock types, should provide bracketing ages for the time of foliation development, may assist in determining the protolith to the gneiss, and, coupled with the previously mentioned dating site, provides a test of commonality of age of this type of megacrystic unit.

### **Diorite, Monzodiorite and Quartz Monzodiorite**

A few outcrops of rocks ranging in composition from diorite to quartz monzodiorite have been subdivided into, i) diorite and monzodiorite, and ii) quartz monzodiorite in Figure 3. The rocks are darker weathering than the granitic and granodioritic gneisses, being grey, black, or locally dark pink, but are otherwise

similar (i.e., medium to coarse grained, recrystallized and foliated to gneissic). Amphibole is a major mafic mineral, in contrast to the granitic and granodioritic gneisses. An association with the granodioritic gneiss seems to exist in some cases. A single outcrop of monzodiorite in the southwest corner of NTS map area 13B/04 is sandwiched between granodioritic gneiss and amphibolite and may represent a transition between the two. Quartz monzodiorite from immediately east of the Upper St. Augustin River pluton is a subsidiary rock type associated with amphibolite and may represent nothing more than contamination between injected granitic material and its mafic host.

### **CRITERIA FOR IDENTIFYING MEDIUM- TO HIGH-GRADE QUARTZOFELDSPATHIC METASEDIMENTARY GNEISSES**

The identification of the protolith of metamorphosed supracrustal rocks that are the product of extreme differentiation in the sedimentary environment, such as pelites, quartzites, marbles–calcareous rocks and iron formation from alumina-, silica- carbonate-rich, and ferruginous sediments, respectively, or rocks that are texturally distinct, such as conglomerates, heterolithic pyroclastic rocks and pillow lavas, is not a serious challenge for field geologists accustomed to working in high-grade terrains. Conversely, distinguishing between medium- to high-grade quartzofeldspathic metasedimentary gneisses and those derived from igneous rocks of similar composition (e.g., fine-grained felsic volcanic rocks) remains as lively a problem now as it was two hundred years ago. The comments below summarize some of the criteria used to discriminate between



**Plate 7.** Close-up of part of the same outcrop as Plate 6. Mafic selvages to coarser grained granitic material suggests local melting. The slivers and lenses of lighter coloured K-feldspar-rich material in the granodiorite may represent former K-feldspar megacrysts. Geochronology site.

psammitic gneiss and granitic–granodioritic plutonic orthogneiss in the Grenville Province in eastern Labrador. The possibility that the psammitic gneisses might have been derived from felsic volcanoclastic rocks is acknowledged, but extending the discussion to this question goes well beyond rational limits of protolith discrimination in these rocks.

i) A useful starting point for considering quartzofeldspathic gneisses to be of supracrustal origin is the association with rocks of less equivocal sedimentary parentage, such as quartzite, calc-silicate rocks and pelites. If the quartzofeldspathic gneiss is interlayered in a regular, concordant manner with such rocks (or even regionally associated), then it is reasonable to suspect that both have the same origin, rather than the quartzofeldspathic rocks being later, injected granitic sheets. The more intimate the interlayering, the greater the probability of a sedimentary protolith.

ii) Even if the composition is not so extreme so as to exclude normal igneous rocks, abnormally high or low proportions of specific minerals (especially quartz) provide a good indication of a sedimentary protolith. It is also worth remembering that igneous rocks having anomalous compositions tend to reflect their immediate host rocks or more distant precursors. Muscovite-bearing pegmatites intruding pelitic gneisses is a good example.

iii) Quality of banding (layering) is a helpful, although far from diagnostic criterion. Banding may be formed in many secondary ways, among which deformation is one of the most common, but it seems axiomatic that rocks having good banding to start with, are more likely to end up as those showing the best-developed banding in a high-grade metamorphic state. Banding/bedding reflects compositional heterogeneities between individual layers, some of which will have lower minimum melting temperatures than others, so partial melting is more likely to emphasize, rather than obliterate, original structure. In more homogeneous rocks, such as granitoid intrusions, partial melting produces more irregular melt patches.

iv) In thin section, quartzofeldspathic rocks derived from clastic metasedimentary rocks commonly retain vestiges of rounded grains, the outlines of which can commonly still be discerned despite fairly extensive recrystallization. Quartz grains tend to show less strain than their igneous counterparts and feldspars sporadically show embayed grain boundaries. Plagioclase is typically more heavily sericitized and less well twinned, and K-feldspar is normally microcline. Grain size contrasts commonly exist between individual layers.

v) Phyllosilicates seen in thin section, include more muscovite and chlorite in psammitic gneiss than in their igneous counterparts and tend to occur as interstitial material at grain boundaries between rounded quartz or feldspar grains, and/or concentrated into particular layers. Interstitial material may also include amphibole and epidote, generally having a rather ragged habit, and also tending to be concentrated into particular layers. Commonly, this material is too fine grained to identify individual minerals, simply having a 'grungy', non-descript appearance. These minerals simply reflect incomplete sedimentary differentiation to alumina-rich or calcareous products, perhaps originally forming cementing material.

vi) A wider range of opaque minerals may be present in psammitic gneiss and include magnetite, ilmenite, pyrite, hematite and leucoxene. Hematite commonly occurs as a coating to quartz grains and serves to emphasize clastic grain boundaries. Magnetite/ilmenite may be concentrated



**Plate 8.** Close-up of part of same outcrop as Plate 6 showing concordant amphibolite interlayered with granitic melt. Geochronology site.



**Plate 9.** K-feldspar megacrystic granodiorite (lower part) in contact with well-banded granodioritic/psammitic gneiss. Geochronology site.

into heavy mineral layers, and, rarely, is associated with other durable minerals such as zircon. Garnet and more unusual minerals, e.g., tourmaline, are more conclusive of a sedimentary protolith, but are not often found.

vii) Accessory minerals, such as titanite, apatite and zircon, are more commonly dispersed single grains, rather than occurring in clumps associated with mafic silicate minerals as they do in granitoid rocks. Roundness of grains is not diagnostic, but is not to be dismissed. Delicate, skeletal or

ameboid grains, or those with abundant inclusions, are less likely to withstand the rigours of fluvial transportation and, if seen, decrease the probability of a metasedimentary protolith. Nevertheless, one must be alert to branching secondary minerals in metasedimentary rocks that were formed during subsequent metamorphism. Titanite is a common culprit, and tends to be present in those rocks having most chlorite (both minerals being products of biotite breakdown).

viii) Anomalous features (for a granitoid intrusive rock) may be helpful. One example seen is a large, rounded quartz grain in a fine-grained matrix, located at a compositional boundary between two layers. This must surely represent a small pebble resting on the sediment surface.

#### **RELATIONSHIP BETWEEN GRANODIORITIC GNEISS, K-FELDSPAR MEGACRYSTIC GRANITOID ROCKS AND PSAMMITIC GNEISS**

A dilemma arising from mapping of the Upper Eagle River map region (Gower, 1998) was that some of the rocks mapped as granodioritic gneisses had features suggestive of derivation from a metasedimentary protolith (e.g., slightly anomalously quartz-rich, unusually well banded), but that they lacked characteristics generally taken as diagnostic of supracrustal origin, such as primary sedimentary structures or association with rocks generally regarded as being of unequivocal sedimentary parentage (e.g., quartzite, calc-silicate rocks or aluminosilicate-bearing pelites). This problem was encountered again during mapping of the Crooks Lake and Upper St. Paul River

map regions and in the present area. Mapping in the Upper St. Augustin River map region, perhaps more so than in any of the previous three, has strengthened the notion of a spatial relationship between granodioritic gneiss and metasedimentary gneiss, especially psammitic gneiss, and also with K-feldspar megacrystic granitoid rocks described above (but not with the distinct K-feldspar megacrystic granodiorite to quartz monzonite described in a later section of this report). From a field standpoint, the problem is simply one of deciding what is a granodioritic (ortho)gneiss and what is a psam-

mitic (para)gneiss – pragmatically from which one does not escape by demanding non-genetic mapping. The approach adopted here is to indicate alternative unit designators for those localities considered to be most equivocal, hence offering the reader the conceptual flexibility to recode the map as desired. The association between K-feldspar megacrystic granitoid rocks and metasedimentary gneiss is a different issue that it does not involve naming rocks, but rather why any spatial association should exist at all. The only response offered here is that in the author's experience it is fairly common and might be related to potassium mobilization from any K-rich supracrustal rocks, such as pelite, semipelite or meta-arkose that are also likely to be present.

## **METAMORPHOSED MAFIC ROCKS**

### **Amphibolite**

Black-weathering amphibolite occurs sporadically within the sea of granodiorite/granite (gneiss) and is sufficiently varied to assert that any common origin is unlikely. It ranges from fine to coarse grained, may show relict primary igneous textures or be thoroughly deformed to a schistose or gneissic rock, and be homogeneous or heterogeneous. Heterogeneity is caused by hornblende-rich pods and veneers, as well as concordant/irregular white quartz-feldspar veins and melt patches.

Some amphibolites are particularly distinctive. One example in the centre of NTS map area 13B/04 is a plagioclase-porphyratic recrystallized rock, having a medium-grained, weakly foliated matrix that retains relict diabasic texture. Plagioclase phenocrysts are euhedral to subhedral and up to 1 cm across. Its contact with foliated K-feldspar megacrystic granodiorite is exposed, but as it is faulted, uncertainty remains whether the amphibolite is a xenolith or mafic dyke. A second example is a coarse-grained amphibolite near the eastern border of NTS map area 13B/06. It retains a partial igneous texture and could be alternatively termed metagabbro. A third example is in the centre of NTS map area 13B/06, which contains scapolite (the only rock in the map region known to do so) with 20 percent of the accessory opaque minerals being sulphide.

### **Metamorphosed Mafic Intrusion in the Northwest of NTS Map Area 13B/04**

A triangular-shaped area covering about 150 km<sup>2</sup> in the northwest part of the map region is inferred to be underlain by mafic intrusive rocks. These belong to an extensive body first mapped in the Crooks Lake to the north (Gower, 1999) and the Kenamu River map region to the northwest (James and Lawlor, 1999), and subsequently to the west by James and Nadeau (2000). Within the St. Augustin map region, the

body is very poorly exposed. Six exposures were located. Each exposure is texturally and compositionally different, comprising medium-grained gabbro, fine- to medium-grained leucogabbro, medium-grained melanocratic monzogabbro and medium- to coarse-grained K-feldspar rich monzogabbro. Partly related to composition, the rocks weather white, pale pink, grey or black, and are homogeneous and weakly foliated. The range of compositions is similar to that seen in the same body farther north, but exposure is inadequate to delineate meaningful subunits within the body, although the locations of monzogabbro and leucogabbro have been indicated in Figure 3. Relict igneous textures are partially preserved in some of the samples, whereas a few are more thoroughly recrystallized. Primary igneous layering or lamination was observed in two outcrops (Plate 10), supporting previous statements that the body is a layered mafic intrusion (Gower, 1999; James and Nadeau, 2000). The rocks are intruded by minor pegmatite and microgranite dykes and transected by late-stage fractures along which chloritic or hematitic alteration is evident. A prominent positive magnetic anomaly occurs in the vicinity of the two outcrops where layering was observed, and could imply a magnetite-rich zone, perhaps similar to that seen farther north in the same body (Gower, 1999). Alternatively, it might be entirely unrelated – perhaps caused by a small, unidentified, late- to post-Grenvillian granitoid stock, for example.

### **Metamorphosed Mafic Rocks in the Southwest of NTS Map Area 13B/03**

Three outcrops of mafic rock in the southwest corner of NTS map area 13B/03 are grouped as part of a mafic intrusive body, subsequently intruded by a late- to post-Grenvillian monzonite pluton. One of these very close to the western boundary of the St. Augustin River map region was previously visited by Eade (1962), who mapped it as gabbro (his Unit 7). No extension of the unit to the west is indicated on the map of James and Nadeau (2000), who broadly refer to rocks in the area as granitoid orthogneiss with amphibolite boudins. To the south, rocks affiliated with the Petit Mecatina anorthosite–monzonite–charnockite–granite (AMCG) suite are depicted on the map of Avramtchev (1983b). Although not directly correlative with any of the rocks belonging to the suite (monzonite, anorthosite or anorthositic gabbro) purported to exist immediately south of the border, it is nevertheless possible that the mafic rocks described here could be genetically associated.

All three outcrops are grey- or black-weathering, medium- to coarse-grained, recrystallized mafic rocks. Two are foliated amphibolite, whereas the one in the extreme southwest corner of the map region retains vestiges of an igneous fabric and is better described as a melanocratic metagabbro, although only relict pyroxene remains in the cores of mafic



**Plate 10.** *Medium-grained metagabbro. The contrasting lighter and darker zones above and below the hammer head may indicate former primary igneous layers.*

grains and is surrounded by amphibole. Traces of pyrite were seen on a fracture surface in the easternmost mafic rock exposure.

#### MEALY MOUNTAINS INTRUSIVE SUITE

On the basis of a distinct positive aeromagnetic anomaly and sparse outcrop, a 7-km-diameter circular body of monzonite to syenite is inferred to exist in the centre of NTS map area 13B/05. The outcrops weather pink, red, buff or rusty brown, and the rocks are homogeneous and do not show planar or linear fabrics. Grain size varies from fine to coarse. The rocks lack quartz but have abundant K-feldspar. Plagioclase is relegated to interstitial status, or occurs as relict, embayed grains within a sea of K-feldspar. Mafic mineral content is low and includes clinopyroxene that has exsolution features characteristic of inverted pigeonite. The rocks are recrystallized, distinct from the near-pristine textures seen in most late- to post-Grenvillian intrusions. On this basis and petrographic comparisons (especially the presence of inverted pigeonite), the body has been assigned a late-Labradorian age, although geochronological data are currently lacking. Similar syenite to monzonite bodies have been mapped in various places along the eastern and southern fringes of the Mealy Mountains Intrusive Suite (Gower and van Nostrand, 1996; Gower, 1998; James and Nadeau, 2000) and have been mapped as satellite plutons to the suite, and it seems likely that this body belongs to the same group, although none have been dated.

#### METADIABASE

A black-weathering, fine- to medium-grained mafic metadiabase was found in the southeast part of the map region. This rock is distinctive as it retains its primary igneous texture despite recrystallization. The mineral assemblage is orthopyroxene, clinopyroxene, amphibole, biotite, opaque minerals, plagioclase and secondary epidote. Plagioclase is particularly noteworthy in that it forms poikilitic, late-crystallizing grains, up to 5 cm long.

The affiliation of the metadiabase is unknown, but it is sufficiently unlike other mafic rocks in the region that it may have a separate origin (regardless of it being on strike with amphibolite to the northeast). It differs from any suite of mafic dykes in eastern Labrador, including the two geographically closest and temporally most likely known contenders, namely the 1250 Ma Mealy dykes (Hamilton and Emslie, 1997) or the 979 Ma West St. Modeste dyke (Wasteneys *et al.*, 1997). It may be related to the Petit Mecatina AMCG suite.

#### K-FELDSPAR MEGACRYSTIC GRANODIORITE TO QUARTZ MONZONITE

The westward continuation of a distinctive K-feldspar megacrystic granodiorite to quartz monzonite previously mapped farther east (Gower, 2000), was found in the southeastern part of the Upper St. Augustin River map region, but does not extend very far into it. The unit forms three apparently separate bodies that may be structurally dismembered parts of a single intrusion, and/or be linked at depth. It contrasts lithologically from other K-feldspar megacrystic units farther west, especially on the basis of a relative high mafic mineral (biotite) content, and large and abundant subhedral to euhedral K-feldspar megacrysts, up to 4 by 3 cm in outline, and only partly recrystallized. The rock is pink-weathering, homogeneous, and generally moderately to strongly foliated, but massive locally. Nowhere does it have a gneissic appearance and it is not migmatized, and, to the contrary, parts of it appear unrecrystallized or only weakly so. These rocks do not show the mantled textures, characteristically seen in the late- to post-Grenvillian intrusions. The rock is sparsely intruded by microgranite and pegmatite dykes and contains a few irregular amphibolite enclaves up to about 30 cm long. The intrusion's age is unknown. The best current

judgement is that it postdates most of the other gneissic and foliated granitoid rocks in the region, but predates the late- to post-Grenvillian plutons. This inference is based on its relatively coherent form, homogenous aspect and lack of severe recrystallization.

It will not escape the reader's notice that these rocks are situated on the east side of a northeast-trending fold in a comparable position to K-feldspar megacrystic granodiorite described in an earlier section situated on the west flank of the structure. The obvious conclusion, that they are correlative, has not been overlooked and, such may be the case. Indeed, petrographic studies provide no confirmation that the two currently differentiated units are distinct. However, until the two units can be shown to be correlative they are best treated separately.

### LATE- TO POST-GRENVILLIAN GRANITOID INTRUSIONS

On the basis of collective field characteristics, and on topographic and aeromagnetic expressions, most of the rocks described below can be confidently assigned to a suite of late- to post-Grenvillian (966 to 956 Ma) plutons widespread throughout the southeastern part of the eastern Grenville Province (*cf.* Gower *et al.*, 1991). Units are indicated lithologically on Figure 3, but are described on a pluton-by-pluton basis below. Names of plutons are given on Figure 5.

#### Joir River Granite

This granite is only exposed along the Joir River and three of its more incised tributaries, so its overall shape is inferred from its aeromagnetic signature. The body continues west of the map region, where it was originally mapped by Stevenson (1967) and subsequently by James and Nadeau (2000). The depiction of Stevenson (1967) was the basis for its small extrapolation eastward into NTS map area 13B on the compilation of Avramtchev (1983c). Combining outcrop data from the present study, plus a brief incursion into NTS map area 13C/01 during mapping of the St. Augustin River map region, together with information from Stevenson (1967) and James and Nadeau (2000), the Joir River granite is constrained to be farther north than depicted by Stevenson (1967), larger to the east than the guess of Avramtchev (1983c), and smaller than that indicated by James and Nadeau (2000). Note that sparsity of exposure still allows for some latitude in interpretation of its size. Based on an aeromagnetic high, the intrusion is elongate in an east to northeast direction.

Typically, the granite is pink-weathering, coarse grained, massive and texturally uniform between outcrops.

Only on the northwest side is any textural variation evident, the rocks being less coarse grained and having a slightly seriate appearance, possibly indicating proximity to the margin of the intrusion. Grain size is between 0.5 and 1.0 cm, although some K-feldspar crystals are locally up to about 1.5 cm long. Quartz is unrecrystallized, but is fractured. Based on studies elsewhere, a pink feldspar seen in stained slabs that is neither K-feldspar nor typical plagioclase is probably albite. The dominant mafic mineral is biotite, but minor amphibole is locally present. Elliptical to subangular enclaves of fine- to coarse-grained, black-weathering amphibolite, up to 50 cm long, were seen at two outcrops on Joir River. Enclaves of foliated to gneissic material up to 40 cm across are also present, and it is clear that the fabric in the enclaves predates emplacement of the granite. The most obvious origin for the mafic enclaves is from the metamorphosed mafic intrusion to the north. Microgranite dykes are present locally, but generally the granite is lacking in minor intrusions.

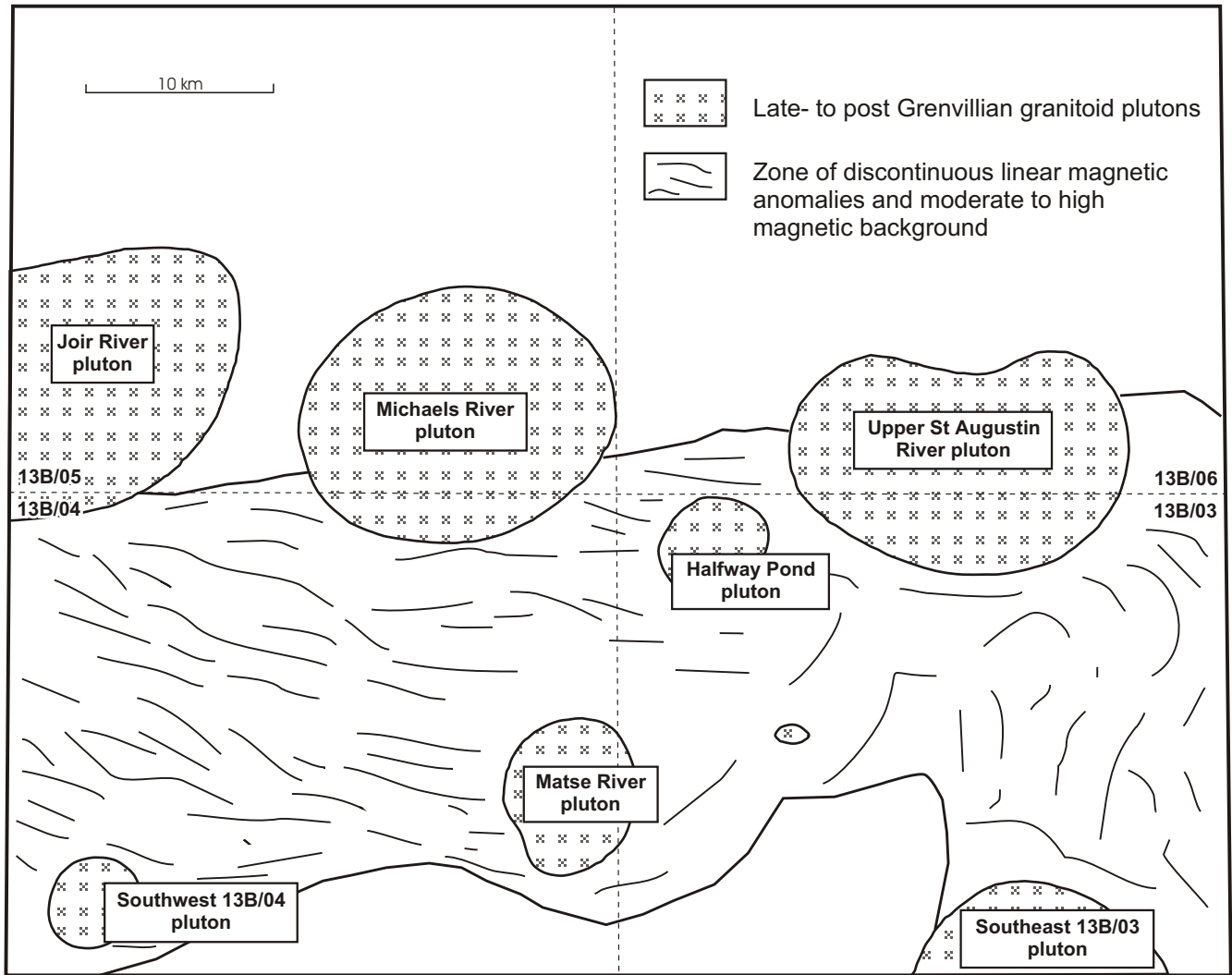
#### Southwest NTS Map Area 13B/04 Monzonite to Syenite

A circular monzonite to syenite body was mapped in the southwest corner of the map region, its extent correlating with more rugged topographic relief than the surrounding area, and its border being inferred from arcuate topographic trends. The intrusion is also expressed by a coincident and pronounced positive aeromagnetic anomaly.

Rocks comprising the intrusion range from monzonite to syenite, which is pink- to buff-weathering, mostly coarse grained (medium grained in places), homogeneous and massive; quartz is minor or absent. The dominant mafic mineral is biotite, but some hornblende is also present. A distinctive textural feature is the presence of mantled feldspars, evident in outcrop by grey cores and pink rims. Stained slabs show that the cores are plagioclase and the rims K-feldspar. Normally, a simple core-rim relationship is present, with the rim making between 30 and 50 percent of the volume of the composite grain. In a few instances, multiple zonation is seen, although individual zones are commonly narrow and discontinuous. The pluton appears to lack minor intrusions or enclaves.

#### Upper Michaels River Monzonite to Alkali-Feldspar Granite

The Upper Michaels River monzonite to alkali-feldspar granite is a newly coined informal name for a circular to slightly elliptical pluton in the centre of the map region. The body differs from most other late- to post-Grenvillian intrusions in that it contains several rock types. From available stained slabs, compositions appear to be increasingly fractionated in a clockwise direction around a country-rock



**Figure 5.** Generalized regional structure of the Upper St. Augustin River map region based on rock fabrics and magnetic patterns. Names given to late- to post-Grenvillian plutons are also indicated.

xenolithic core, starting with monzonite forming the north-east segment, changing to syenite in the south, to quartz syenite in the southwest and to alkali-feldspar granite in the northwest. Age relationships between compositions are unknown. Such a fractionation pattern is unusual and clearly requires further evaluation, but the author knows no reason to deny its feasibility. All the rocks are homogeneous at individual outcrops but texturally, as well as compositionally, different from their neighbours. The rocks are either massive or, rarely, very weakly foliated and contain unrecrystallized quartz (Plate 11). Horizontal jointing, a characteristic feature of the late- to post-Grenvillian granites elsewhere, was seen in a few exposures.

The monzonite and syenite are pink- to buff-weathering, and ubiquitously coarse grained. The dominant mineral is perthitic K-feldspar, associated with plagioclase that

mostly forms relict ovoids enveloped in perthite; quartz, slightly blue in places, is interstitial. Hornblende is the dominant mafic mineral but both biotite and titanite are also present. The rocks lack minor granitoid intrusions, although a few quartzofeldspathic stringers were seen in one outcrop. An interesting feature in some monzonite is the presence of cavities up to about 1 cm in diameter. They were only seen after cutting rock slabs and hence must be primary, rather than the product of weathering. No unusual minerals lining the cavity walls were seen. The syenite to alkali-feldspar granite is pink- to locally reddish-weathering and medium to coarse grained. As in the monzonite-to-syenite, plagioclase forms relict grains, locally exhibiting alternating plagioclase-K-feldspar concentric zonation. K-feldspar is perthitic and texturally similar to that in the monzonite to syenite. Biotite is the dominant mafic mineral, but some relict amphibole is present. No minor granitoid intrusions were



recorded, but a few hematite-filled irregular fractures were seen.

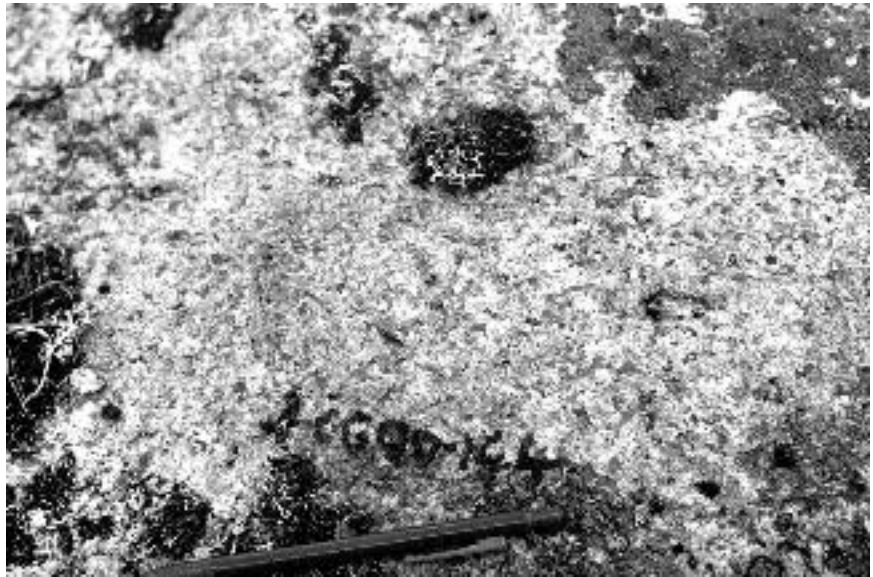
The xenolithic core of the body comprises grey-buff-weathering, strongly foliated, plagioclase-rich rocks having northwest structural trends. Two samples collected are fine grained, finely laminated and very leucocratic, whereas the third is medium grained, unlaminated and mesocratic. The protolith of these rocks is uncertain, but contenders include plagioclase-rich greywacke, volcanoclastic compositional equivalent, leucodiorite or metamorphosed leucogabbro.

One other outcrop deserves mention. It occurs at the eastern margin of the pluton and consists of a grey- to black-weathering, schistose, fine-grained, recrystallized, two-pyroxene, amphibole-bearing mafic granulite intruded by a few white-weathering, quartzofeldspathic veins. A nearby (100 m to the southeast) outcrop of massive to weakly foliated monzonite implies that the mafic granulite is most likely within the pluton, and therefore a xenolith.

#### **Matse River Quartz Monzonite to Quartz Syenite**

The Matse River quartz monzonite to quartz syenite (informal new name) forms a near-circular body in plan about 7 km in diameter. The outline of the intrusion as shown here does not differ radically from that of Eade (1962), a remarkably acute judgement on his part, denied as he was of aeromagnetic information, and basing his interpretation on topographic patterns combined with observation of the rock at a single data station close to the centre of the body. Unfortunately, this depiction was later corrupted in the compilation of Avramtchev (1983b), who showed this body and one farther to the southeast as a single intrusion.

The pluton is made up of a pink- to buff-weathering, coarse-grained, massive, homogeneous monzonite, showing only limited lithological variation. As with other late- to post-Grenvillian monzonitic intrusions in the region, it is characterized by mantled feldspars, typically having grey plagioclase cores and pink K-feldspar rims. Some multiple concentric zonation between plagioclase and K-feldspar was also observed. K-feldspar also occurs intergrown with plagioclase, and interstitial to plagioclase and quartz. Both hornblende and biotite are present and clinopyroxene was equivocally identified in two samples. Unlike other late- to post-Grenvillian intrusions in the area, minor granitoid intrusions are common and pegmatite dykes locally present,



**Plate 11.** Typical coarse-grained, massive, unrecrystallized late- to post-Grenvillian granite. Michaels River pluton.

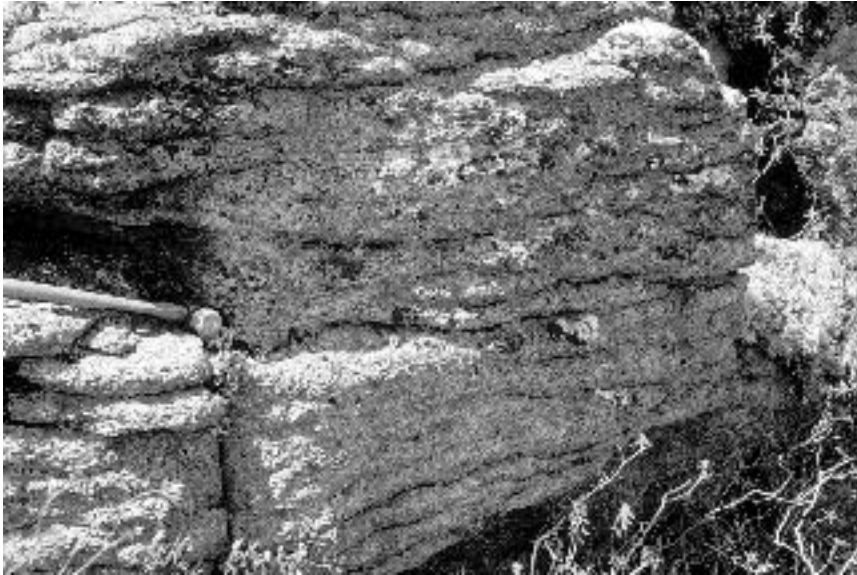
one of which is cored by a 60 by 20 cm pod of quartz. Exposures of the body on the Matse River are close to its western margin (which was located to within 100 m in one place) and differ in having a higher plagioclase content and commonly containing angular mafic enclaves. One unusual mafic rock contains large (2 by 3 cm), recrystallized, elliptical plagioclase phenocrysts enveloped by a fine-grained, recrystallized, strongly foliated and slightly migmatized plagioclase-mafic mineral matrix. Inasmuch as exposure allows judgement, the rock appears to form a narrow elongate body. It might be a deformed mafic dyke, but as the host rock is massive and unmetamorphosed it is probably an anomalous mafic enclave.

#### **Halfway Pond Granite**

The Halfway Pond granite is the most poorly exposed of the late- to post-Grenvillian plutons in the map region. The few outcrops present indicate that it is pink-weathering, massive, coarse-grained, homogeneous, and has a seriate-tending to K-feldspar-megacrystic texture. Biotite is the dominant mafic mineral. Enclaves or minor granitoid intrusions are lacking, except at one outcrop at the western border of the intrusion, where well-banded granitic gneiss is intruded by late- to post-Grenvillian granite.

#### **Upper St. Augustin River Monzonite to Granite**

The Upper St. Augustin River pluton is a newly discovered and named intrusion situated mostly in the southern part of NTS map area 13B/06. It is subdivided into monzonite, quartz monzonite and granite. Compositional and



**Plate 12.** *Horizontal jointing characteristic of late- to post-Grenvillian granitoid rocks. Upper St. Augustin River pluton.*

textural variations are evident from slab to slab within each of the three subunits defined, and are considered to indicate that there are gradational lithological changes within, and probably between, subunits. Rocks within the intrusion are pink-weathering (very locally pale grey or buff), massive to very weakly foliated, coarse grained, homogeneous and unrecrystallized. The rocks are even-textured, but not equigranular. K-feldspars are generally the largest crystals present and reach about 2 by 3 cms locally, although usually about 1 cm or less. Biotite  $\pm$  hornblende are the characteristic mafic minerals. Minor granitoid intrusions are absent, but an exception was recorded at a site near the southern boundary of the intrusion. Horizontal jointing, characteristic of late- to post-Grenvillian plutons elsewhere, was seen in some outcrops (Plate 12). One rock, mapped as a syenite, is fine to medium grained, has a weak foliation, and was noted on outcrop as containing biotite-rich portions. Although clearly not typical pluton material, it remains uncertain whether the rock is an enclave or represents an internal border between separate pulses of magma comprising the pluton. Present ground mapping provides no endorsement for magmatic individuality, although magnetic patterns could be interpreted to indicate otherwise.

#### **Central NTS Map Area 13B/03 Quartz /Monzonite**

A small stock is depicted west of the centre of NTS map area 13B/03 on the basis of one outcrop of pink- to buff-weathering, homogeneous, coarse-grained, hornblende-biotite, unrecrystallized quartz monzonite. Its outline is drawn on the basis of a small positive magnetic anomaly.

#### **Southeast NTS Map Area 13B/03 Monzonite to Granite**

Only part of this pluton is situated within the Upper St. Augustin River map region, the remainder being located in Quebec, where its presence is recognized (although extended much too far west) on the map of Avramtchev (1983b). Within Labrador, the intrusion is mostly a pale pink to rusty grey-buff, massive to very weakly foliated, homogeneous, unrecrystallized, coarse-grained monzonite, locally grading into quartz monzonite. Textures are seriate to megacrystic and mantled-feldspars are common being characterized by grey plagioclase cores and pink K-feldspar rims. Both biotite and hornblende are present. No minor granitoid intrusions or enclaves were recorded, but an epidote-filled fracture seen at one outcrop demonstrates some late-stage fluid

activity. Two outcrops of coarse-grained granite on the east flank of the intrusion have also been assigned to the body, although they differ somewhat texturally.

#### **Microgranite and Pegmatite**

Late-stage, planar microgranite/aplite and pegmatite dykes commonly discordantly intrude foliated or gneissic host rocks and have been alluded to earlier. Attention is specifically drawn here to several outcrops of massive or weakly foliated, fine- to medium-grained, pink- to red-weathering homogeneous microgranite/granite (locally with associated pegmatite) that occur in the western part of the map region, in terrain otherwise almost completely devoid of exposure.

The point of interest is that the outcrops are distributed like a string of beads in an arcuate zone flanking the east side of the Joir River granite and the circular syenite to the north. A more audacious mapper might have linked them as a single body. Similar rocks are found farther northeast where, in cases where intervening outcrop was lacking, Gower (1999) regarded the exposures as representing minor, but preferentially exposed, intrusions, within an unexposed host rock. Such is also thought to be the case here.

#### **STRUCTURE**

On the basis of foliation trends considered to reflect older structures coupled with magnetic signatures, a major fold structure deformed rocks older than the late- to post-Grenvillian plutons. The fold has a northeast axial trace

located in NTS map area 13B/03, hence most of the map region is situated on its northwest flank. A 'marker band' of discontinuous, elongate magnetic anomalies that correlates with metasedimentary gneiss – granodioritic gneiss – K-feldspar megacrystic granodiorite association discussed earlier is suggested to outline the fold. Utilizing the magnetic data requires conceptually excluding the anomalies related to the late- to post-Grenvillian plutons. This interpretation is presented in Figure 5, drawing on the magnetic data of Figure 4. It is rendered tentative by rather erratic orientations of foliations and lack of knowledge of their relative ages.

As previously reported (Gower, 1998, 1999, 2000), foliations having a prevailing northwesterly trend are believed to be younger, but superimposed on rocks containing the earlier fabric in a sporadic manner. Minor folds, that might lend support to the above fold hypothesis, were only rarely seen and provide only inconclusive evidence. Isoclinal folding was seen in some of the psammitic gneisses, but not in other rocks.

The late- to post-Grenvillian plutons are also a major factor in distorting any systematic syn- or pre-Grenvillian deformational pattern that might exist. The plutons in this map region are of sufficient size and abundance to exert a significant influence on pre-existing fabrics and certainly appear to have done so, at least adjacent to the intrusions. Furthermore, if late- to post-Grenvillian intrusions of batholithic proportions exist at depth as suggested earlier, then it seems unlikely that many pre-pluton structures have escaped distortion.

Late-stage brittle faults were not seen, except very minor structures in specific outcrops. A major northwest-trending fault is suggested to transect the northern part of the map region on the basis of a few linear topographic features and possible offset of some of the foliated to gneissic units. The proposed fault does not derive much endorsement from magnetic data and its inclusion is not essential to the overall geological interpretation presented here. That it might exist derives some encouragement from extrapolation to the southeast and northwest. To the southeast, in the Upper St. Paul River map region, the possible fault is on line with a linear magnetic discontinuity thought to represent a significant structural break (Gower, 2000), and to the northwest, it is on alignment with a fault depicted by James and Lawlor (1999) in the Kenamu River map region. The structure is also parallel to a late-stage brittle fault through Fourmont Lake farther west shown by James and Nadeau (2000), and to the St. Augustin River in the very southernmost part of the map region and much of the river's length in Quebec, farther south. It seems quite likely that a swarm of such fractures exists, although not necessarily causing much regional disruption.

## METAMORPHISM

Metamorphic grade is at amphibolite facies, and possibly lower amphibolite grade, in places. Garnet was not found anywhere in the map region. All occurrences of pyroxene (except in enclaves in late- to post-Grenvillian granitoid rocks) are in rocks of anomalous composition, and are not diagnostic of granulite-facies conditions.

The two outcrops of pelitic gneiss are both characterized by quartz–plagioclase–K-feldspar–biotite–sillimanite–accessory minerals. Neither the quartzite nor psammitic gneiss contain mineral assemblages conducive toward determining metamorphic grade, comprising quartz–plagioclase–K-feldspar–biotite–accessory minerals, but evidence of melting is present in the psammitic gneiss.

The mineral assemblage in the foliated and gneissic granitoid rocks is similar to that in the psammitic gneiss, with the addition of hornblende locally. Pyroxene was not identified in any outcrop of granite or granodioritic gneissic rock.

Late- to post-Grenvillian rocks have primary textures and igneous mineral assemblages. Unrecrystallized quartz is evidence that these rocks escaped the last deformational event to affect the region. The presence of cavities suggests a fairly high level of emplacement. Two-pyroxene mafic granulite enclaves within the Upper Michaels River monzonite to granite and Matse River pluton are interpreted as a xenoliths of unknown origin. Minor hematite-, epidote- or prehnite-filled fractures indicate late-stage, low-grade metamorphism and brittle deformation.

## ECONOMIC POTENTIAL

No mineral occurrences have been previously reported from the area and no claims were staked within the map region during the 1994 to 1995 Labrador staking rush. Remoteness, poor exposure, lack of mineralization, or geophysically or geochemically attractive targets remain formidable deterrents to embarking on mineral exploration in the region. Present mapping offers little justification for modifying current unfavourable assessments.

Only three localities offer any direct encouragement, and only then to the very optimistic. These are a magnetite-rich pegmatite situated near the central eastern border of the map region, traces of pyrite recorded in a late-stage fracture in mafic rocks in the southwest corner of the map region, and biotite sheets over 20 cm across mentioned by Eade (unpublished field notes, data station EA61-018). Beyond that, the only obvious inducements to explore deemed noteworthy here are provided by, i) an unexplained distinct pos-

itive magnetic anomaly (Figure 4) along the northern border (central part), and ii) two areas with lake-sediment geochemical anomalies. The positive magnetic anomaly might be due to oxide accumulations within layered mafic rocks. Such layered rocks are known to exist in the vicinity, and, farther to the north, an oxide mineral occurrence (with traces of sulphide) was found in the same mafic body (Gower, 1999). The lake-sediment anomalies are for several elements including U, Mo, Cu, Pb and Zn, but also Mn and Fe (McConnell, 1978, 1979). In the southwest of NTS map area 13B/04, the lake-sediment anomalies coincide with a late- to post-Grenvillian monzonite to syenite, but such rocks elsewhere have not yielded evidence of mineralization, beyond minor fluorite in one alkali-feldspar granite (Gower, 1998). The geochemically anomalous area in the southern part of NTS map area 13B/03 is underlain by foliated to gneissic granite. Direct evidence of faulting, based on slickensides plus hematite staining (Eade, unpublished field notes, data station EA61-029, 1961), coinciding topographically with a series of aligned small lakes and connecting streams, point to a possible mineralized fracture.

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