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GEOLOGY OF THE MINIPI LAKE AREA (NTS 13C/SOUTH): NEW DATA FROM THE SOUTHERN MEALY MOUNTAINS TERRANE, GRENVILLE PROVINCE, LABRADOR

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ABSTRACT

The Minipi Lake area, southern Labrador, contains parts of two Grenvillian terranes; the Mealy Mountains terrane, and a terrane of uncertain age and tectonic affinity, provisionally correlated with the Mecatina domain. In the study area, the Mealy Mountains terrane mainly includes variably recrystallized and deformed, pyroxene-bearing monzodiorite, monzonite, syenite, and gabbro to gabbronorite that belong to the Labradorian-age Mealy Mountains intrusive suite. The terrane also includes upper amphibolite-facies granitoid orthogneisses inferred to have pre-Labradorian emplacement ages. Generally, tectonic fabrics in the terrane strike to the northeast and are tentatively assigned as Labradorian structures.

The Mecatina domain, in the southern part of the study area, includes foliated to strongly foliated and augenitic, K-feldspar porphyritic granite, quartz monzonite and gabbro. The igneous rocks, which are undated, contain local inclusions of quartzite and pelitic gneiss that may correlate with pre-1500 Ma supracrustal rocks of the Wakeham Group. Tectonic fabrics in the igneous rocks are mainly west-northwest striking. Local occurrences of mylonitic rocks along the contact between the Mecatina domain and the Mealy Mountains terrane suggest the contact is tectonic and possibly Grenvillian in age. The Mecatina domain and the Mealy Mountains terrane are intruded by plutons of fresh, late- to post-Grenvillian, K-feldspar porphyritic granite and medium- to coarse-grained isotropic granite.

Field work in 1999 did not result in any new or significant discoveries of economic minerals. However, the Grenville Province in southern Labrador is under explored and exploration opportunities do exist. The region has potential for hosting Ti (Fe) oxide deposits in anorthosite, and Ni–Co–Cu mineralization in anorthosite and gabbro.

INTRODUCTION

With few exceptions, the geology of the Grenville Province in regions south and southwest of Goose Bay, including parts of NTS map areas 13B, 13C and 13D (Figures 1 and 2), is known only from 1:250 000 or smaller scale reconnaissance mapping completed by the Geological Survey of Canada more than 30 years ago (*cf.* Stevenson, 1967). As part of a continuing and systematic program by the Geological Survey of Newfoundland and Labrador to upgrade the geological database for this region, most of the southern part of NTS map area 13C, including areas 13C/1, C/2, C/3, C/6, C/7 and C/8, representing an area of approximately 5500 km^2, was mapped at a scale of 1:100 000 in a six-week field season. Work was based from a field camp at Minipi Lake, located approximately 100 km southwest of Goose Bay.

In general, bedrock in the study area is very poorly exposed; outcrops are found mainly on hilltops or along small streams. Contacts between rock units are not exposed; in some cases contacts are interpreted from aeromagnetic anomaly patterns. The area is thickly vegetated or is covered by extensive areas of bog. Some of the northeastern and southern parts of the study area especially the Little Mecatina River valley, contain thick accumulations of Quaternary glaciofluvial sand. Lakes and rivers are shallow, rocky, and are generally lacking in shoreline outcrops. Ground traversing is arduous and very inefficient. Thus, mapping was accomplished almost entirely by making helicopter landings

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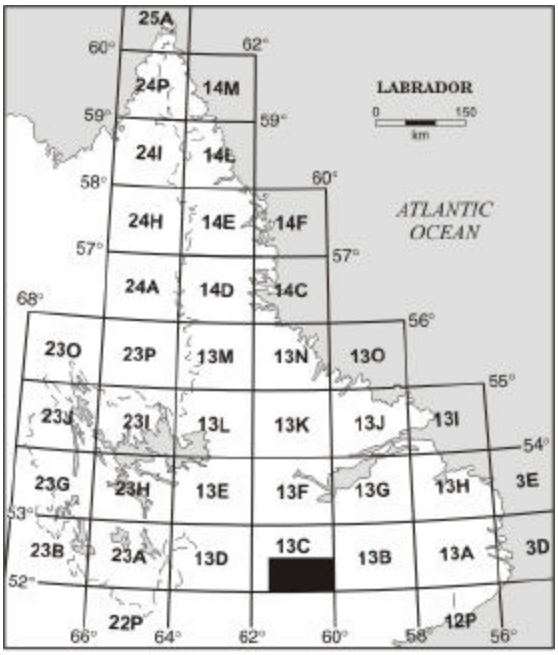

Figure 1. *NTS index map of Labrador showing location of the 1999 study area.*

on isolated outcrops. A very minor amount of the mapping, in the area south of Fourmont Lake, involved ground traversing. Outcrops along the shore of Minipi Lake were examined using a boat. In addition to the normal obstacles and annoyances that can impede geological map making, the study area includes a bombing range [the range is approximately 1100 km2 and centred about 20 km southwest of Minipi Lake] used by NATO fighter jets. In the summer months, access to this area is restricted and low-level flying by civilian aircraft and ground-traversing could be hazardous hence workers are required to report their intentions to the Military Coordination Centre in Goose Bay, and when training is ongoing, field mapping may need to be postponed.

In 1999, field work was a continuation of 1:100 000-scale mapping initiated in NTS map area 13C/NE in 1998 (*see* James and Lawlor, 1999), and is part of an ongoing program to complete 1:100 000-scale mapping in southern and eastern Labrador (*see* Gower *this volume*; and Gower, 1999 and references therein). The study area was previously mapped by Stevenson (1967). The northwestern part of NTS map area 13C/NW was mapped by Wardle *et al.* (1990). Preliminary results of the 1999 mapping program were reported by James and Nadeau (1999).

REGIONAL SETTING

The study area is divided into two domains on the basis of rock types (Figure 3). The northern domain, including units P_{MM} mdq, P_{MM} mzt, P_{MM} gbr (Figure 4), comprises rocks belonging to the late Paleoproterozoic (Labradorian-age) Mealy Mountains intrusive suite (MMIS). This conclusion is based on correlation of rock types (*see* James and Lawlor, 1999); there are no geochronological data from rocks in the study area. The MMIS consists mainly of an older group of anorthositic, leucogabbroic and leucotroctolitic rocks that are not present in the study area, and a younger group of pyroxene-bearing monzonite and quartz monzonite (e.g., units P_{MM} mdq and P_{MM} mzt). A pyroxene monzonite and pyroxene granite, inferred to be from the younger group of rocks and occurring in the northeastern part of the MMIS, have emplacement ages of 1646 ± 2 Ma and 1635 +22/ 8 Ma (Emslie and Hunt, 1990), respectively. The MMIS is not an anorogenic AMCG suite. Emplacement ages overlap with regionally significant tectonothermal and magmatic events defined as the Labradorian Orogeny, which occurred in northeastern Laurentia in the interval between 1720 and 1600 Ma (*see* Gower, 1996). On the basis of age and tectonic setting, the MMIS is correlated with other mid- to late-Labradorian mafic intrusive suites in northeastern Laurentia (e.g., with the Ossok Mountain intrusive suite in western Labrador; see James, 1994).

The MMIS underlies much of the Mealy Mountains terrane (MMT) (Gower and Owen, 1984), one of several thrust-stacked Grenvillian terranes that make up the northeastern Grenville Province (Figure 2). The MMT consists primarily of Labradorian-age crust (*see* Emslie, 1976; Emslie and Hunt, 1990; Krogh *et al.*, 1996), minor amounts Paleoproterozoic pre-Labradorian crust, Pinwarian (1510 to 1450 Ma) and Grenvillian (ca. 980 to 950 Ma) intrusions. The terrane straddles the boundary between the Interior Magmatic Belt and Exterior Thrust Belt (*see* Gower, 1996) of the northeastern Grenville Province. The northwestern boundary of the MMT is a Grenvillian tectonic contact with the Wilson Lake terrane. The location and nature of the southern and western boundaries of the MMT are uncertain. The boundary between the MMT and the Pinware terrane (Gower *et al.*, 1988), occurring 200 km east of the study area, is a Grenvillian tectonic contact (Gower, 1996). The MMT has been variably overprinted by Labradorian (1720 to 1600 Ma), Pinwarian (1530 to 1450 Ma), and Grenvillian (ca. 1050 to 950 Ma) tectonothermal events.

The southern domain includes intrusive units P_3 kpg, P_3 qmm and P_3 gbr, and metasedimentary rocks (P_2 qtz). The ages of these units are unknown, although provisional field interpretation suggests the intrusive rocks are not part of the MMIS. The significance of this interpretation will be discussed in a subsequent section, although the local occurrence of mylonitic rocks from near the inferred contact between the domains indicates the contact is tectonic, at least locally. These data suggest that the southern domain

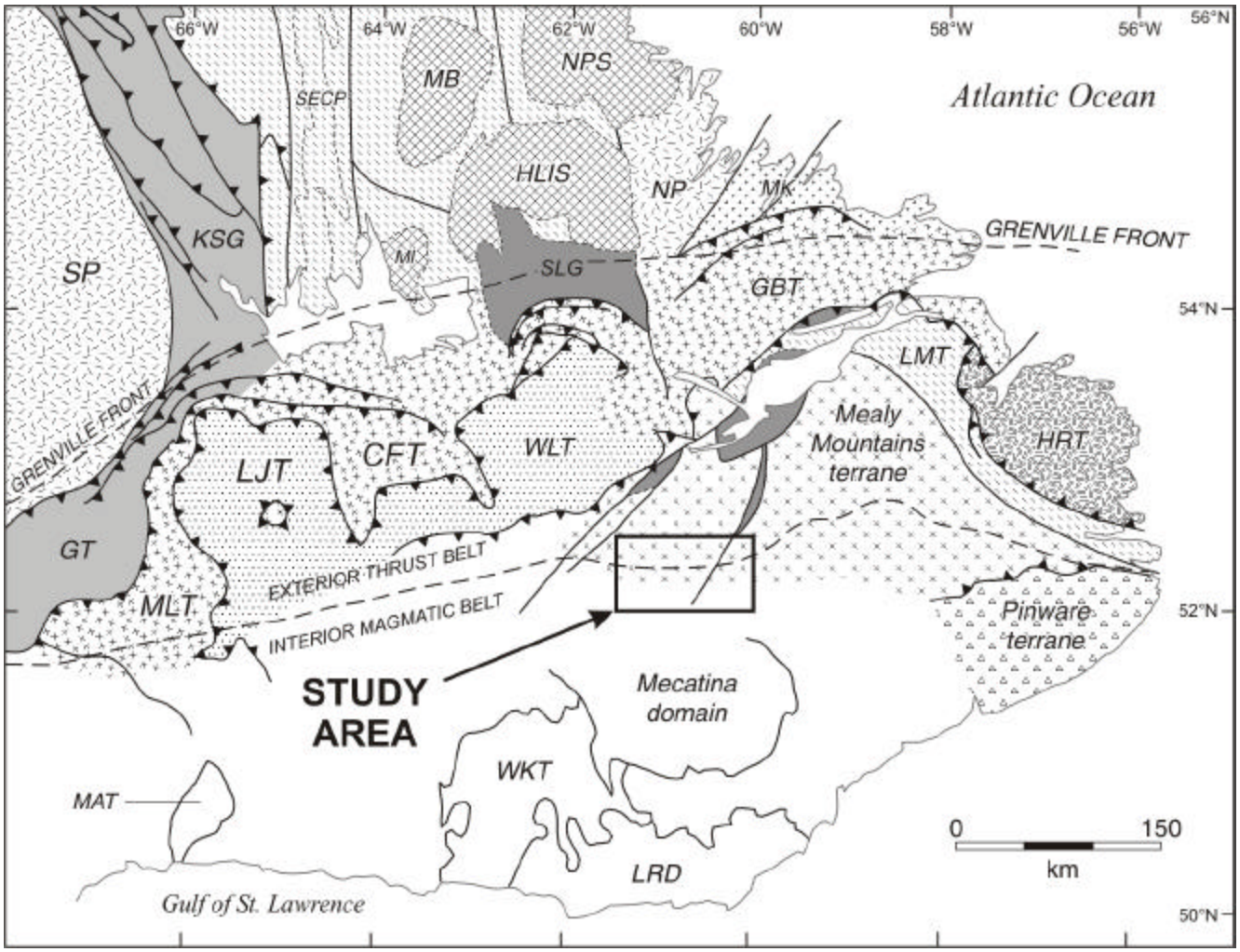

Figure 2. *Location of the Minipi Lake study area in relation to the tectonic and major lithotectonic units of northeastern Laurentia. Grenville Province: HRT - Hawke River terrane, LMT - Lake Melville terrane, GBT - Groswater Bay terrane, WLT - Wilson Lake terrane, CFT - Churchill Falls terrane, LJT - Lac Joseph terrane, MLT - Molson Lake terrane, GT - Gagnon terrane, MAT - Matamec terrane, WKT - Wakeham terrane, LRD - La Romaine domain. Archean divisions: SP - Superior Province, NP - Nain Province (Hopedale Block). Archean and Paleoproterozoic divisions: MK - Makkovik Province, SECP - Southeastern Churchill Province (core zone), KSG - Kaniapiskau Supergroup (2.25-1.86 Ga). Mesoproterozoic units: NPS - Nain Plutonic Suite, HLIS - Harp Lake intrusive suite, MB - Mistastin batholith, MI - Michikamau Intrusion, SLG - Seal Lake Group.*

may not be part of the MMT; rather it may represent the northern extension of the Mecatina domain (Figure 2), or be part of a presently undefined Grenvillian terrane consisting primarily of Mesoproterozoic intrusive rocks and older (pre-1500 Ma ?) supracrustal rocks not found in the MMT. This model remains to be tested. The Mecatina domain consists, in part, of the Petit Mecatina AMCG suite, which is of undetermined age.

DESCRIPTION OF ROCK UNITS

PALEOPROTEROZOIC UNITS

Orthogneiss (P_1 ggn)

The southeastern area is underlain by a unit consisting of upper amphibolite-facies, white- or pink-weathering

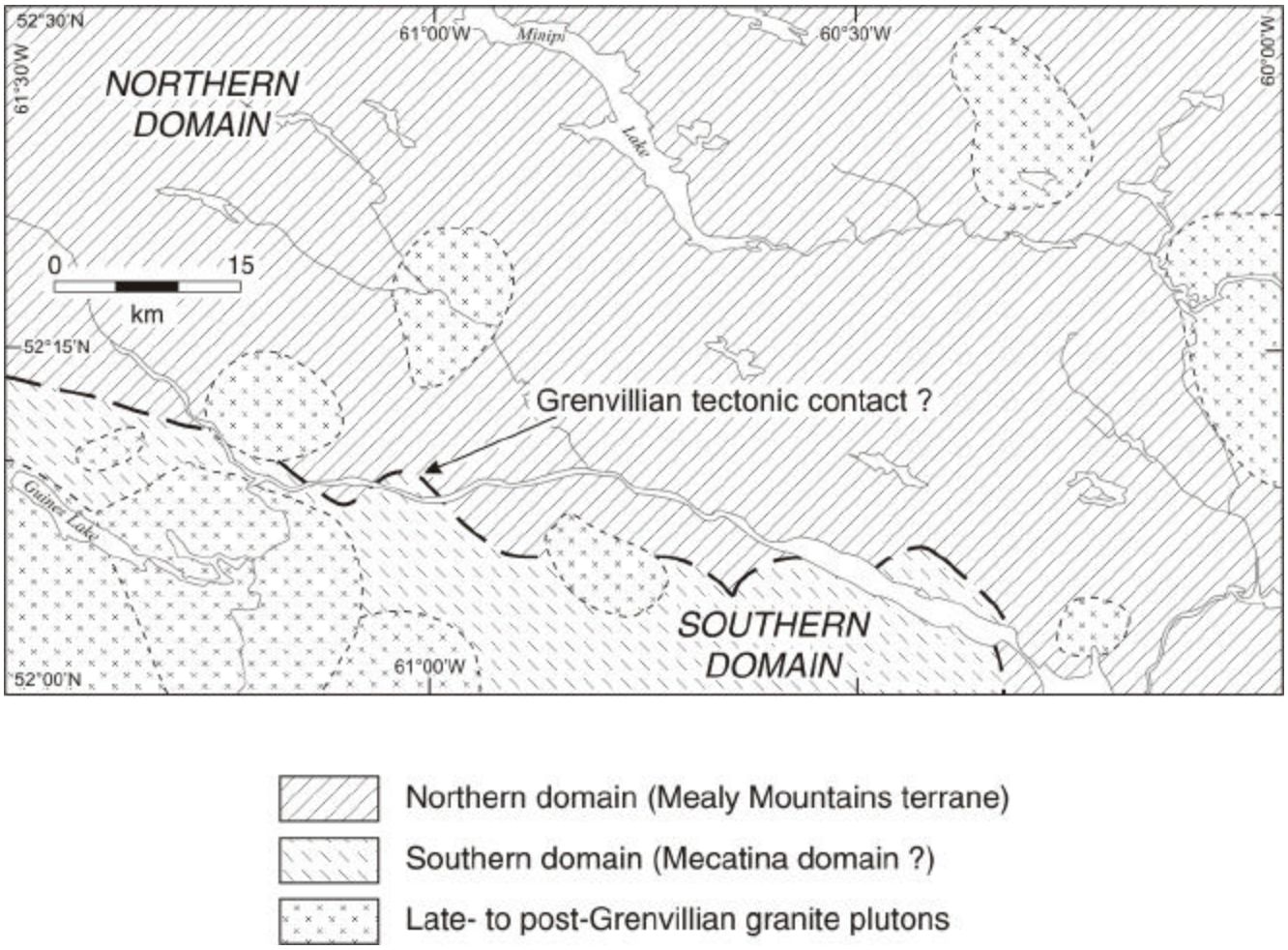

Figure 3. *Lithological domains, Minipi Lake area.*

granitoid orthogneiss, and metagranitoid rocks. The unit is interpreted to be the oldest in the northern domain, although contact relations with surrounding units are not exposed. On the basis of lithology, the unit is provisionally correlated with other units of pre-Labradorian orthogneiss occurring elsewhere in the MMT (e.g., Krogh *et al.*, 1996, and references therein).

White-weathering orthogneiss is common in the western parts of Unit P_1 ggn. Rocks have a fine- to medium-grained, granoblastic tonalite paleosome, and contain less than 20 percent, white, tonalite or granitic leucosome (Plate 1). Gneissosity in the paleosome is defined by layers containing relatively high concentrations of biotite, although generally, layering is diffuse and poorly defined. The tonalite leucosome is discordant to gneissosity in the paleosome, but is itself deformed. One occurrence of white orthogneiss at

Plate 1. *Folded, white-weathering tonalite orthogneiss containing pink, granitic leucosome (left side of the photograph), occurring in the northwestern part of Unit P_1 ggn.* (Photo DJ-99-010)

the outlet of Fourmont Lake (UTM 684486E, 5767937N), consists of medium-grained, biotite- and hornblende-bearing metatonalite containing isoclinally folded layers of amphibolite (Plate 2). The amphibolite layers, which make up approximately 20 percent of the outcrop, are generally less than 20 cm thick, although layers greater than 1 m thick also occur. The amphibolite layers are interpreted as pre-metamorphic mafic dykes.

The northeastern parts of the unit are most commonly comprised of pink-weathering granitic orthogneiss. Rocks consist of pink- to grey-weathering granitic paleosome and pink, granitic leucosome (Plate 3). The paleosome contains biotite and locally has a texture suggesting the protolith was a K-feldspar porphyritic granite. Up to 20 percent of outcrops consist of one or two phases of granitic leucosome distinguished on the basis of texture and crosscutting relationships. The older phase is fine grained and forms thin layers, and streaky, discontinuous lenses. The younger phase, which crosscuts the older phase, is coarse grained and forms thin sheets (less than 30 cm thick); both the older and younger phases are deformed. The pink orthogneiss commonly contains boudins of medium-grained biotite amphibolite interpreted to be relics of pre-metamorphic mafic dykes. Also included in the unit are occurrences of pink-weathering, foliated metagranite containing biotite and amphibolite boudins that are identical to those found in the gneissic rocks.

The southeastern part of the unit also consists of pink granitic orthogneiss containing amphibolite boudins, although rocks in this area are extensively recrystallized and the gneissosity is commonly obliterated. In general, rocks have very fine-grained granoblastic textures and indistinct foliations. They contain less than 10 percent biotite and have relic K-feldspar porphyritic textures, locally.

The orthogneisses are interpreted to represent the relics of a pre-Labradorian (i.e., pre-1720 Ma) plutonic complex that was intruded by the MMIS. It is uncertain if upper amphibolite-facies metamorphism of the gneisses predated emplacement of the MMIS. The U–Pb geochronological studies, necessary to resolve these problems, are in progress.

Plate 2. *Strongly foliated tonalite orthogneiss containing isoclinally folded amphibolite layers.* (Photo DJ-99-101)

Plate 3. *Pink granitic orthogneiss containing two phases of pink granitic leucosome. The older phase (right side of the photograph) forms thin (<10 cm), discontinuous layers that are cut by thicker layers of coarser grained leucosome (left side of the photograph). The paleosome contains a relict K-feldspar porphyritic texture.* (Photo DJ-99-068)

Mealy Mountains Intrusive Suite

Monzodiorite, Quartz Monzodiorite and Monzonite (P_{MM} mdq)

Unit P_{MM} mdq is a compositionally and texturally varied unit. It includes monzodiorite, quartz monzodiorite,

monzonite, diorite, granodiorite, quartz monzonite and granite (Plate 4). Rocks are texturally varied, even at the outcrop scale, from massive with complete preservation of igneous textures to recrystallized and foliated; gneissic varieties also occur. The unit probably consists of distinct intrusions of relatively uniform composition although the unit is so poorly exposed that it cannot be subdivided at the present scale of mapping. However, this study informally defined it to include all Mealy Mountains intrusive suite rocks that cannot be mapped as either monzonite (Unit P_{MM} mzt) or gabbronorite (Unit P_{MM} gbr). The unit can be traced to the north, into NTS map area 13C/NW where it was mapped by James and Lawlor (1999). Similar rocks were mapped by Gower (1999) in NTS map area 13B/NW. This heterogeneous division makes up a significant part of the western MMIS. The U–Pb date of a weakly gneissic quartz monzodiorite from the unit give a preliminary age of 1659 ± 5 Ma (James *et al., this volume*), interpreted to be the age of igneous emplacement.

In general, rocks are fine to medium grained. They are most commonly recrystallized and foliated. The unit includes a wide variety of rock types, although almost all rocks from the unit contain some proportion of clinopyroxene. Hornblende and biotite are also common. Magnetite is a common accessory mineral.

Plate 4. *Foliated, clinopyroxene-bearing quartz monzodiorite (Unit P_{MM} mdq) having a granoblastic texture.* (Photo DJ-99-198)

The unit, as the contacts are represented in Figure 4, also includes occurrences of gabbro and gabbronorite, correlated with Unit P_{MM} gbr on the basis of composition. It also includes several occurrences of granitoid orthogneiss equivalent to Unit P_1 ggn, and an occurrence of mafic gneiss (UTM 616253E, 5780508N), which may represent metamorphosed mafic volcanic rocks. Generally, gneissic versions of PMM mdq rocks have a gneissosity defined by concentration of mafic minerals, contain clinopyroxene and are relatively poor in quartz. By comparison, granitoid orthogneisses of Unit P_1 ggn have a gneissosity defined by layers of granitic leucosome, do not contain clinopyroxene and have more than 20 percent quartz.

Monzonite and Syenite (P_{MM} mzt)

In the northeastern area, the MMIS includes a pluton consisting of pyroxene-bearing monzonite and syenite. Contacts of the pluton are unexposed and age relationships with surrounding units are somewhat uncertain, although aeromagnetic anomaly patterns (*see* Figure 5) suggest the monzonite is intruded by gabbronorite (P_{MM} gbr) along its western margin. Based on the fact that Unit P_{MM} mzt rocks are massive and unrecrystallized, as compared to the generally foliated and recrystallized rocks of the previously described Unit P_{MM} mdq, it might be tacitly assumed that emplacement of the P_{MM} mzt pluton postdated emplacement and recrystallization of P_{MM} mdq rocks. However, arguments to support interpretation of relative ages based on the presence or absence of tectonic fabric elements or degree of recrystallization are weak. U–Pb geochronological studies are necessary to unequivocally date the time of emplacement of Unit P_{MM} mzt in the study area. Pyroxene-bearing monzonite and syenite, identical to Unit P_{MM} mzt, make up a significant portion of the western MMIS in areas north and northeast of the study area (James and Lawlor, 1999; Gower, 1999).

In the study area, the unit consists of distinctively red- to orange-weathering monzonite and syenite. Rocks are medium to coarse grained and massive. They contain less than 10 percent clinopyroxene and accessory magnetite. The unit has a consistent texture and composition. Outcrops lack inclusions or dykes.

Gabbro and Gabbronorite (P_{MM} gbr)

Mafic intrusive rocks in the northern domain are collectively defined as Unit P_{MM} gbr. The unit has a wide range in composition, textures, structures, and aeromagnetic signatures, possibly indicating that it consists of intrusions of different ages. However, it could not be subdivided at the present scale of mapping. Unit P_{MM} gbr rocks are correlated with mafic intrusive rocks of the MMIS on the basis of lithology, and that they can be traced from the study area into better defined parts of the MMIS proper, to the northeast (*see* Gower, 1999).

Unit P_{MM} gbr consists mainly of gabbro and gabbronorite. It contains subordinate amounts of leucogabbro, leucogabbronorite, pyroxenite, diorite and very minor amounts of monzogabbro, monzogabbronorite and amphibolite. Rocks consist of varied amounts of clinopyroxene, orthopyroxene and plagioclase. Locally, plagioclase is pale pink on fresh surfaces. Biotite is a common accessory mineral; biotite-bearing rocks are most common in the northwestern part of the study area. Trace amounts to several percent of pyrite are common throughout the unit. There are no occurrences of anorthosite in the study area.

Rocks are varied from massive and unrecrystallized, containing preserved igneous mineral textures, to foliated and pervasively recrystallized. Locally, rocks display relic igneous layering defined by concentration of mafic minerals. In some rocks, the foliation may represent a modified relic igneous lamination. The reason(s) for the wide variety of textures and structures in the unit are somewhat unclear. A model proposing that Unit P_{MM} gbr consists of mafic intrusions that predate and postdate a deformation event (Labradorian ?) might be apropos in some cases. However, wide variations in strain and degree of recrystallization are, in some instances, very local and occur over several metres. These local variations cannot be easily explained by intrusions of different ages. Rather, they may be explained by heterogeneous strain; the state of strain being influenced perhaps by original textures or variations in grain size. For example, coarse-grained, isotropic rocks may be less amenable to developing a tectonic foliation than adjacent finer grained rocks containing an original igneous lamination.

Some parts of the unit have a distinctive magnetic signature. Of note is a gabbronorite intrusion southeast of Minipi Lake, marked by an anomalously high, circular magnetic anomaly, 9 km in diameter. Like most parts of Unit P_{MM} gbr, this intrusion is very poorly exposed; the contacts are defined entirely by the magnetic anomaly pattern. Three outcrops within the circular pattern consist of recrystallized gabbronorite containing several percent pyrite. The rocks have a weak layering, interpreted as igneous layering, which appears to be concentric to the outer margin of the intrusion and dips toward the centre of the body, although field data is limited. Circular or elliptical patterns also occur within larger areas underlain by Unit P_{MM} gbr (e.g., a 5-km-long elliptical magnetic high occurring 5 km northwest of the west end of Fourmont Lake; and a 4-km-long magnetic high occurring 6 km north of the east end of Fourmont Lake); these are also thought to define individual mafic intrusions having a distinctive magnetic signature.

MESOPROTEROZOIC AND PALEOPROTEROZOIC(?) UNITS OF UNCERTAIN AFFINITY

Metasedimentary Rocks (P_2 qtz)

Metasedimentary rocks occurring in the southern domain, southwest of Fourmont Lake, are defined as Unit P_2 qtz. The unit includes quartzite and pelitic gneiss. Field relations demonstrate that the pelitic gneiss (not shown in Figure 4) is intruded by quartz monzonite (Unit P_3 qmm). The contact between quartzite and the K-feldspar porphyritic granite (Unit P_3 kpg) is not exposed but assumed to be intrusive. On this basis, the metasedimentary rocks are interpreted to be the oldest rocks in the southern domain. Age and affinity of these rocks is speculative, although they may correlate with units of quartzite, pelitic schist and gneiss occurring in the Pinware terrane (e.g., Gower *et al.*, 1994). Metasedimentary rocks in the Pinware terrane are hypothesized to have depositional ages older than 1500 Ma (Gower, 1996). A second possibility is that they may correlate with rocks of the (pre-1500 Ma) Wakeham Group, which occur in the Wakeham terrane (Figure 2), south of the study area.

Several occurrences of Unit P_2 qtz quartzite form a hilltop, 20 km west southwest of Fourmont Lake (UTM 647090E, 5770848N). Rocks are white on the fresh and weathered surfaces, fine to medium grained, recrystallized and consist almost entirely of quartz (Plate 5), minor amounts of biotite and magnetite. Relict bedding, defined by alternating white and grey layers is preserved.

A zone of pelitic gneiss, less than 100 m wide and several hundred metres long, occurs 5 km southwest of Fourmont Lake (UTM 664135E, 5772083N). Rocks are rusty-, grey- and white-weathering and contain the assemblage biotite + garnet + sillimanite ± cordierite (Plate 6). Sillimanite is abundant suggesting protoliths were aluminous shales or wackes. One outcrop contains garnetite layers up to 5 cm thick. Rocks contain two phases of white-weathering leucosome; the older phase is fine grained and forms thin layers and lenses, whereas the younger phase is coarser grained, forms thick layers (up to 1 m) and contains coarse-grained garnet. Leucosome makes up less than 20 percent of

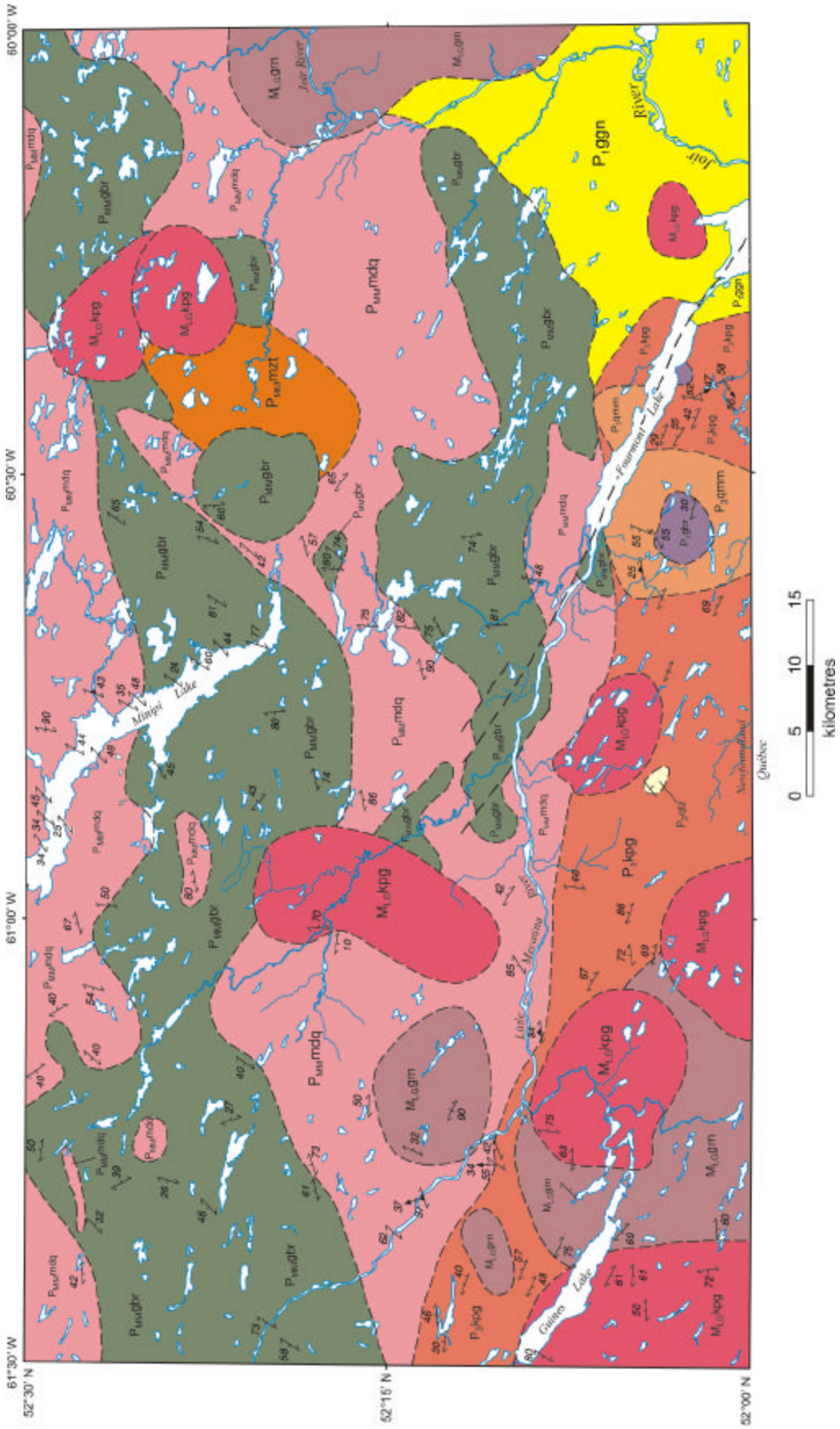

Figure 4. *General geology of the Mingo Lake area*

LEGEND

MESOPROTEROZOIC

LATE-TO POST-GRENVILLIAN GRANITIC ROCKS

M_kpg — Porphyritic granite - K-feldspar porphyritic biotite granite, local weak foliation(generally has a high aeromagnetic signature)

M_grn — Granite - medium- to coarse-grained biotite granite, locally porphyritic,local weak foliation (generally has a low aeromagnetic signature)

PALEOPROTEROZOIC and MESOPROTEROZOIC (?)

INTRUSIVE ROCKS OF UNCERTAIN AFFINITY

P_gbr — Gabbro: fresh to variably recrystallized and deformed gabbro and gabbronorite

P_qmm — Quartz monzonite: foliated, maple-sugar-bronze weathering quartz monzonite and monzonite containing blue quartz

P_kpg — Porphyritic granite: recrystallized, foliated and locally gneissic (augen gneiss) K-feldspar porphyritic granite; contains deformed gabbro dykes

METASEDIMENTARY ROCKS

P_qtz — Quartzite: orthoquartzite and local high-grade pelitic gneiss (not shown)

PALEOPROTEROZOIC

MEALY MOUNTAINS INTRUSIVE SUITE

P_gbr — Gabbro and gabbronorite: variably foliated, recrystallized and deformed to locally fresh gabbro and gabbronorite; contains minor amounts of leucogabbro,melagabbro and pyroxenite

P_mzt — Monzonite: massive, coarse-grained pyroxene-bearing monzonite and syenite

P_mdq — Monzodiorite and monzonite: unsubdivided unit consisting of recrystallized, variably foliated and locally gneissic monzodiorite, monzonite, quartz monzonite and diorite

GNEISSIC ROCKS

P_ggn — Orthogneiss: white and pink-weathering orthogneiss, granitoid migmatite and extensively recrystallized granitic rocks; common amphibolite boudins

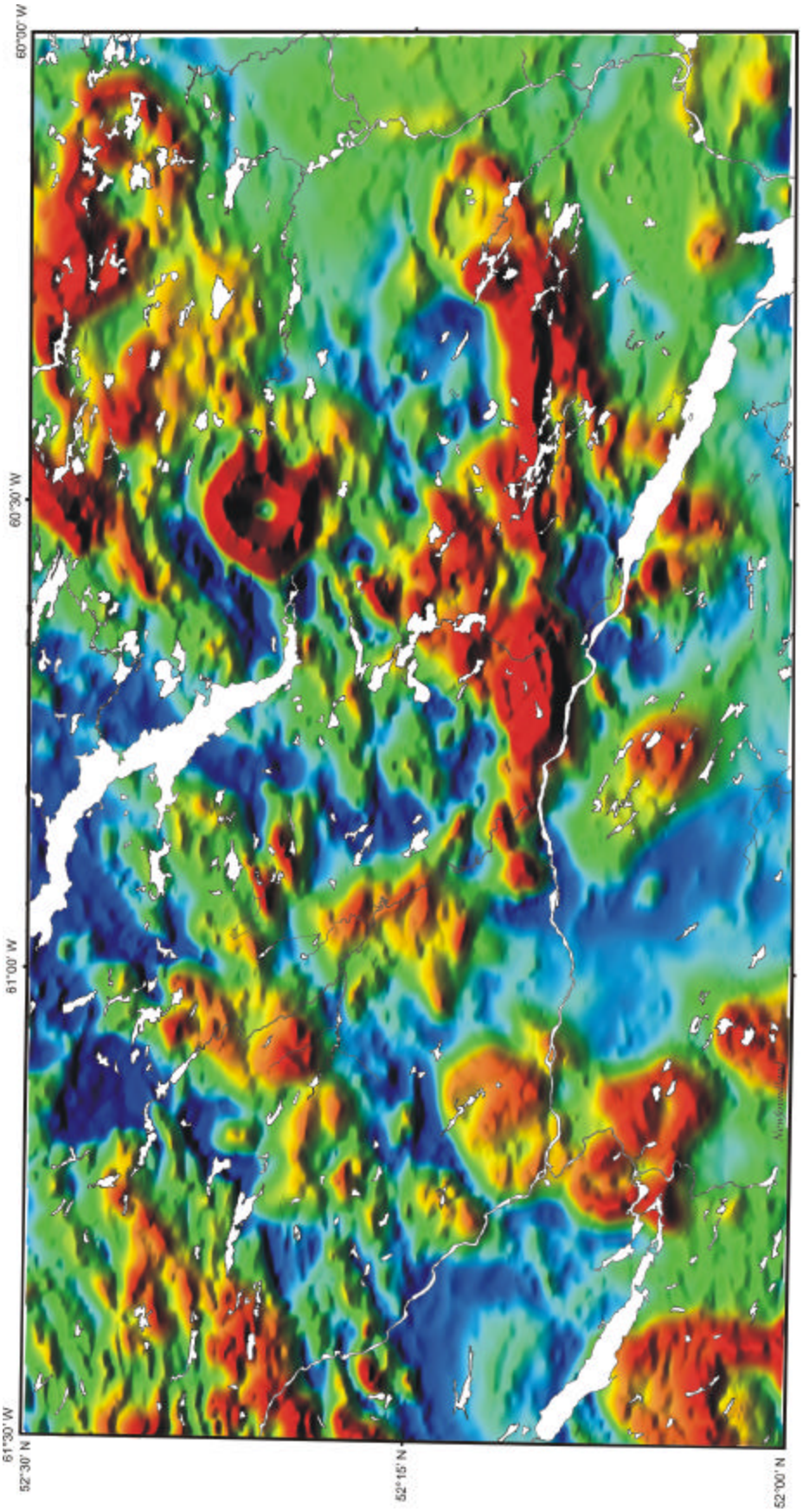

Figure 5. *Shaded-relief magnetic anomaly map of the Minipi Lake area (NTS map area 13C/South). False illumination: azimuth - 315°, inclination - 45°. Red end of the spectrum - magnetic highs; blue end of the spectrum - magnetic lows. Map prepared courtesy of G. Kilfoil, Geochemistry, Geophysics and Terrain Sciences Section, Geological Survey of Newfoundland and Labrador.*

outcrops. Also included in the unit are gossanous pelitic gneisses containing less than 10 percent pyrite.

Porphyritic Granite (P_3 kpg)

The southern domain is mainly underlain by a unit of recrystallized and foliated, K-feldspar porphyritic granite, defined as Unit P_3 kpg. Contacts around the unit are unexposed, although the map pattern suggests it is intruded by Unit P_3 qmm quartz monzonite, Unit P_3 gbr gabbro, and by Units M_{LG} grn, M_{LG} kpg granite intrusions. This model is consistent with the observation that Units M_{LG} grn and M_{LG} kpg intrusions are essentially undeformed, in contrast to Unit P_3 kpg granite, which contains a ubiquitous foliation. Two occurrences of mylonitic granitoid rocks at Fourmont Lake (UTM 671796E, 5774961N and 682168E, 5768233N) occur along the inferred contact between Unit P_3 kpg granite and units in the northern domain. On this basis, the contact is inferred to be tectonic, at least, in part. Foliated and recrystallized gabbro dykes and intrusions of uncertain size (equivalent to Unit P_3 gbr gabbro ?), occur throughout Unit P_3 kpg granite but are too small to be shown on Figure 4. Some of the gabbro dykes have tectonic contacts with surrounding Unit P_3 kpg granite. Age of the P_3 kpg granite is unknown, although the fact that it cannot be correlated with any units in the northern domain, suggests it is not part of the MMIS. However, it is possible that Unit P_3 kpg granite has a Labradorian emplacement age.

Unit P_3 kpg granite is light pink on the fresh and weathered surfaces. It consists of abundant, coarse-grained K-feldspar phenocrysts and finer grained quartz, plagioclase, biotite and local hornblende (Plate 7). Rocks contain less than 10 percent combined biotite and hornblende. The unit has a remarkably consistent composition throughout the study area. In every outcrop of the unit, rocks are recrystallized and foliated; foliation is defined by elongated K-feldspar phenocrysts and biotite. Many rocks have an augen texture defined by extensively recrystallized and elongated phenocrysts (Plate 8). Augen can be up to 15 cm long. Foliation in the unit is west-northwest striking.

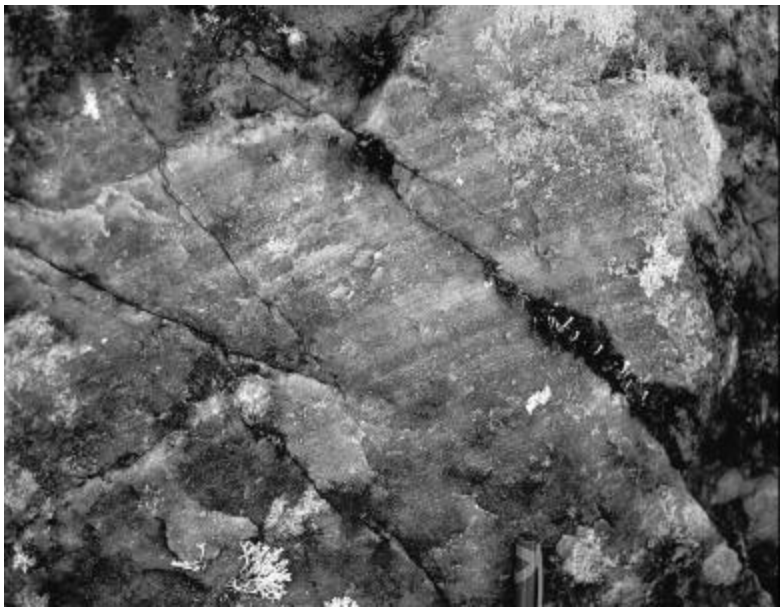

Plate 5. *Unit P_2 qtz quartzite containing relict bedding.* (Photo DJ-99-132)

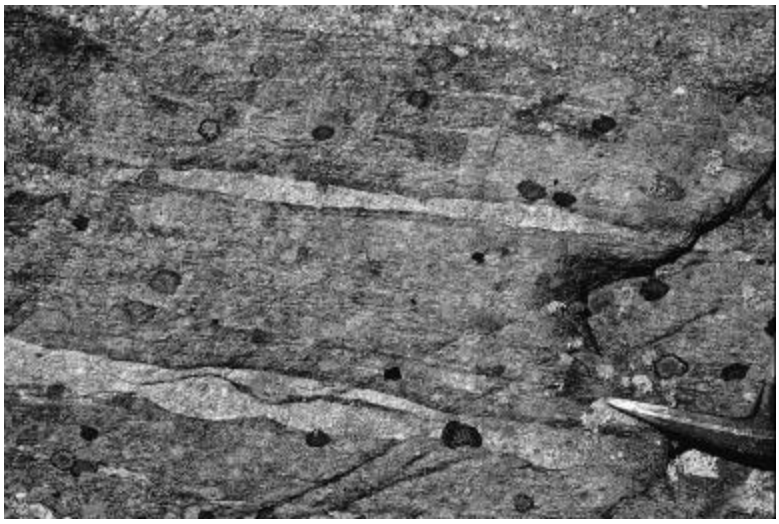

Plate 6. *Pelitic migmatite (Unit P_2 qtz) containing biotite + garnet + sillimanite. These metasedimentary rocks occur as a large screen (at least 500 m long and more than 50 m wide) in Unit P_3 qmm quartz monzonite southwest of Fourmont Lake.* (Photo DJ-99-127)

Quartz Monzonite and Monzonite (P_3 qmm)

A unit of quartz monzonite and monzonite occurring in the southern domain, in the Fourmont Lake area, is defined as Unit P_3 qmm. The unit is inferred to intrude Unit P_3 kpg granite, and is intruded by Unit P_3 gbr gabbro. Locally, Unit P_3 qmm contains inclusions of Unit P2 qtz pelitic metasedimentary rocks. At one locality, on the north shore of Fourmont Lake (UTM 674127E, 5773188N), the unit is intruded by northeast- and northwest-striking, fresh diabase dykes. The northwest-striking dyke cuts the northeast-striking dyke.

The unit consists of quartz monzonite and, less commonly, monzonite (Plate 9). Rocks are maple-sugar bronze

to pink on the fresh and weathered surfaces, and contain pale-blue quartz. They are medium to coarse grained, and K-feldspar porphyritic to isotropic (i.e., approximately equal grained). Typically, they are variably recrystallized and foliated, although massive rocks also occur. Rocks contain less than 10 percent combined clinopyroxene, orthopyroxene(?), biotite, and accessory magnetite. Outcrops commonly contain small (less than 50-cm-long), flattened, fine-grained mafic xenoliths.

Unit P_3 qmm rocks are easily distinguished from the monzonite (Unit P_{MM} mzt) occurring in the northern domain. The latter do not contain quartz, are equal grained, massive, and have a distinctive red to orange colour on the weathered surface. Age and tectonic affinity of Unit P_3 qmm are uncertain, although it may be part of the Petit Mecatina AMCG suite.

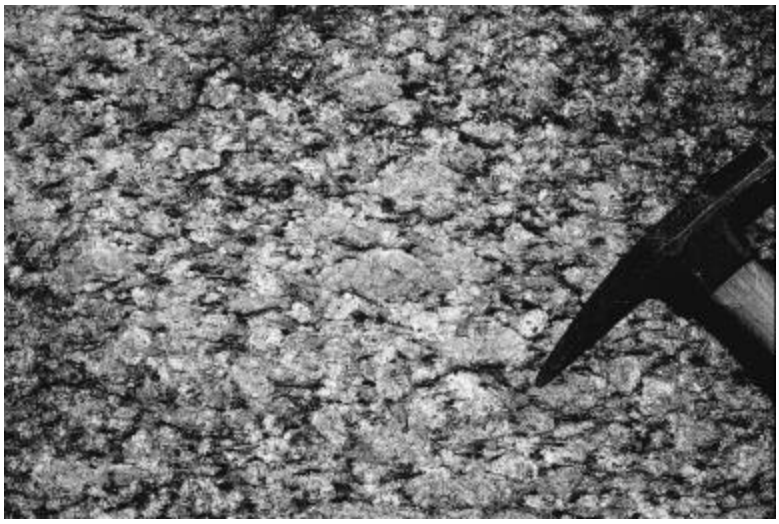

Plate 7. *Typical field aspects of foliated, biotite-bearing K-feldspar porphyritic granite (Unit P_3 kpg).* (Photo DJ-99-110)

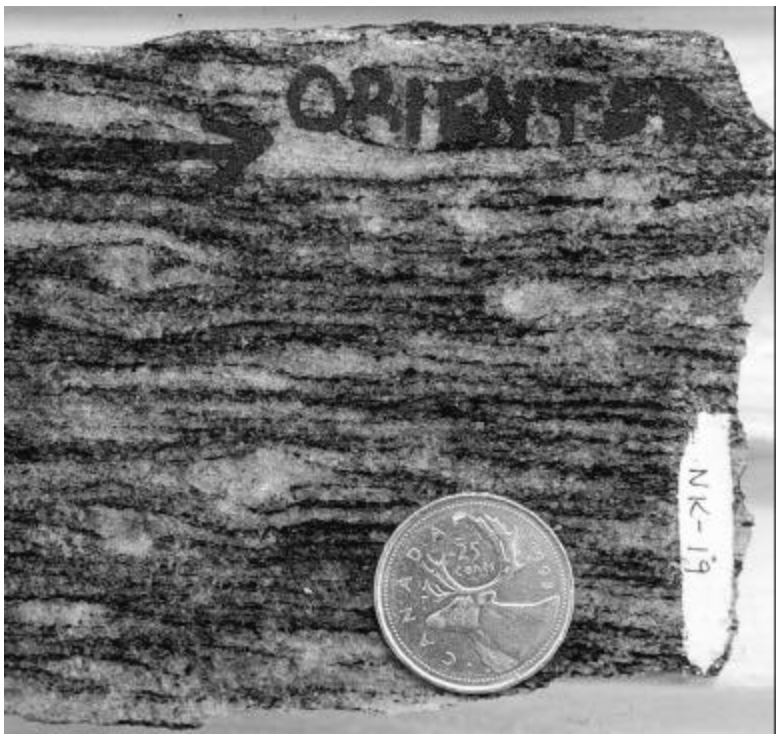

Plate 8. *Strongly foliated and extensively recrystallized K-feldspar porphyritic granite (Unit P_3 kpg) having an augenitic structure.* (Photo NK-19)

Gabbro (P_3 gbr)

Two bodies of fresh to variably recrystallized gabbro occurring in the southern domain are defined as Unit P_3 gbr. The gabbro has a composition similar to rocks in Unit P_{MM} gbr; the units P_3 gbr and P_{MM} gbr are essentially defined on the basis of their occurrence in southern and northern domains, respectively. It is suspected that Unit P_3 gbr is Mesoproterozoic and younger than Unit P_{MM} gbr, although this model remains to be tested. Field relations demonstrate that Unit P_3 gbr gabbro intrudes the quartz monzonite (Unit P_3 qmm). The gabbro is interpreted to intrude Unit P_3 kpg granite, although contacts are not exposed. Unit P_3 kpg granite contains common occurrences of gabbro dykes that may be the same age as the map-scale units of P_3 gbr.

The body of Unit P_3 gbr gabbro contained within the quartz monzonite unit (P_3 qmm) mainly consists of fresh to locally recrystallized and foliated gabbro and melagabbro. Rocks are medium grained and have an intergranular texture defined by plagioclase laths and intergranular clinopyroxene. Relic intergranular textures are preserved in the recrystallized rocks.

Outcrops of fresh, undeformed Unit P_3 gbr gabbro at Fourmont Lake (UTM 679881E, 5771505N) contain spectacular examples of layering and igneous crossbedding structures (Plate 10). Layering is defined by plagioclase concentration. Rocks also have an igneous lamination defined by alignment of plagioclase laths. Thirty metres east of the layered outcrops are occurrences of medium- to coarse-grained and non-layered gabbro, locally having "pillowed" structures defined by rounded (less than 1 m), gabbro pillows. The structure of the outcrop is evident as the margins of the "pillows" are more resistant to weathering, compared to the cores.

MESOPROTEROZOIC UNITS

Late- to Post-Grenvillian Granitic Rocks (M_{LG} grn and M_{LG} kpg)

Rocks in the northern and southern domains are intruded by plutons consisting mainly of medium- to coarse-grained granite (Unit M_{LG} grn) and K-feldspar porphyritic granite (Unit M_{LG} kpg). The units have similar compositions; they are defined on the basis of texture. Both contain rocks that are mainly undeformed and have fresh, phaneritic textures, although weakly foliated rocks occur locally. Of particular distinction, rocks contain unrecrystallized quartz. Some outcrops contain a prominent horizontal jointing. Based on correlation of rock types, the similarity of aeromagnetic signatures, and that the rocks are essentially undeformed, Units M_{LG} grn and M_{LG} kpg are correlated with bodies of late- to post-Grenvillian granite that occur in the Mealy Mountains and Pinware terranes. Where dated, these intrusions have emplacement ages between ca. 980 and 950 Ma (*see* Gower, 1996; Gower *et al.*, 1991).

The medium- to coarse-grained granite (M_{LG} grn) unit consists of pink-weathering biotite syenogranite. Rocks contain less than 10 percent biotite. Equal-grained rocks are most common, although K-feldspar porphyritic rocks also occur. In general, outcrops have a consistent composition, texture and lack xenoliths. However, some outcrops are composites and include two or more separate granite phases that can be distinguished on the basis of grain size and subtle compositional differences. The large bodies of Unit M_{LG} grn granite, occurring southeast of Guines Lake and east of the Joir River, have a subdued magnetic expression.

The K-feldspar porphyritic granite (M_{LG} kpg) unit consists of pink-weathering biotite syenogranite identical in composition to the M_{LG} grn granite. Phenocrysts are up to 5 cm long, and locally display concentric zoning (Plate 11). In rare occurrences, phenocrysts display a weak igneous lamination. In contrast to the M_{LG} grn granite, the bodies of porphyritic granite are marked by prominent magnetic highs.

The study area also includes pink- to white-weathering granitic pegmatites that intrude all of the map units. The pegmatites do not form map units at the present scale of mapping and are not shown on Figure 4. They locally contain very coarse-grained K-feldspar crystals up to 30 cm long. The pegmatites are massive, undeformed and commonly occur around, or within, the Units M_{LG} grn and M_{LG} kpg granite intrusions. For these reasons the pegmatites are interpreted to be late- to post-Grenvillian in age.

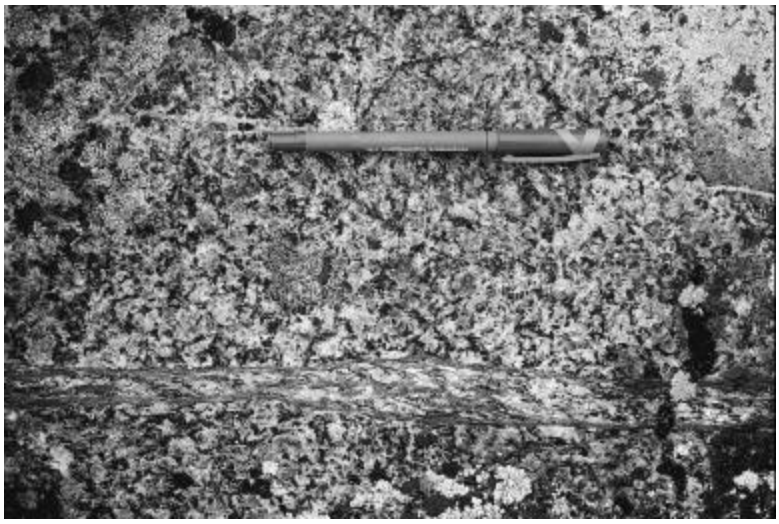

Plate 9. *Variably foliated K-feldspar porphyritic quartz monzonite (Unit P_3 qmm) at Fourmont Lake. The outcrop contains minor west–southwest-striking (Grenvillian?) shear zones.* (Photo DJ-99-084)

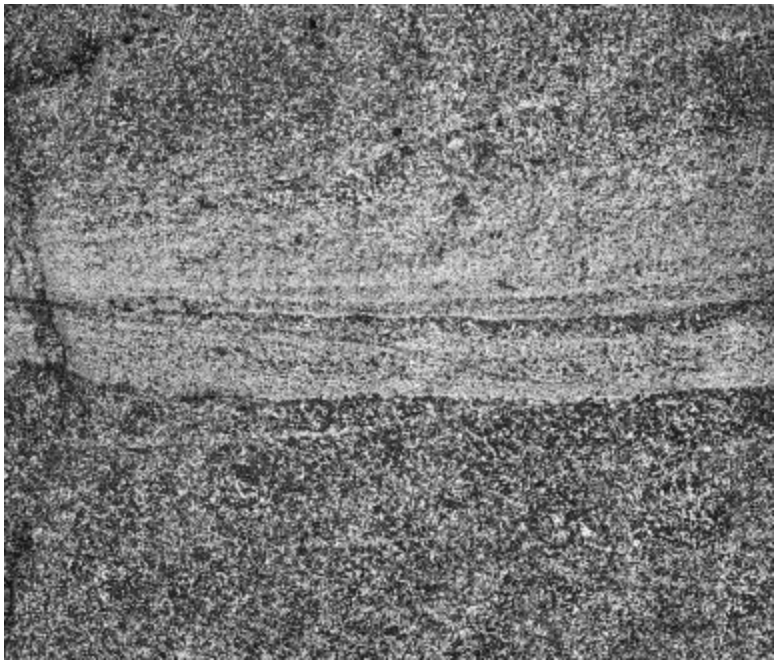

Plate 10. *Preserved igneous layering and "crossbedding" structures in fresh gabbro (Unit P_3 gbr) at Fourmont Lake. Field of view (horizontal dimension) is approximately 50 cm.* (Photo DJ-99-097)

STRUCTURE AND METAMORPHISM

Orthogneisses (P_1 ggn) in the northern domain are metamorphosed to upper-amphibolite facies, containing granitic metamorphic leucosome, and biotite and hornblende in the paleosome. Foliation and gneissosity are mainly east-northeast striking (Figure 6) and dip moderately to the north-northwest. For reasons already discussed it is speculated that these rocks have pre-Labradorian emplacement ages, although the timing of metamorphism and deformation are undetermined. They may have been metamorphosed and deformed during the Labradorian Orogeny.

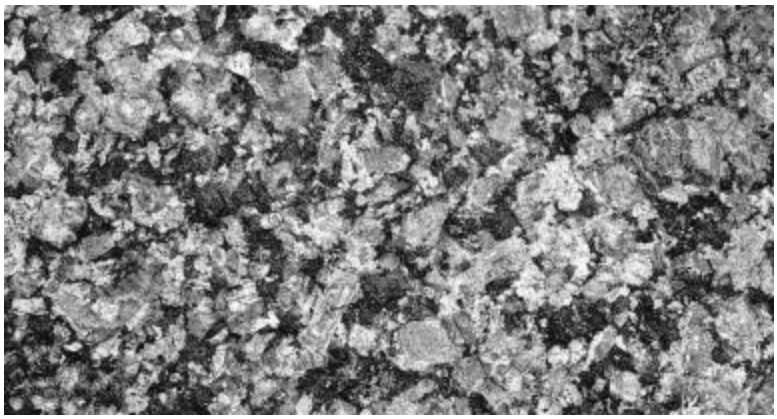

Plate 11. *Massive and coarse-grained K-feldspar porphyritic granite (Unit M_{LG} kpg) containing biotite and magnetite. Locally, phenocrysts have concentric zoning. Field of view (horizontal dimension) is approximately 30 cm.* (Photo DJ-99-047)

Mealy Mountains intrusive suite rocks are variably recrystallized and deformed, although, in general, they cannot be characterized as having a strong or ubiquitous tectonic fabric. Relic igneous textures and minerals are very common in foliated rocks throughout units P_{MM} mdq and P_{MM} gbr. For example, in some occurrences of foliated gabbronorite, plagioclase and pyroxenes that preserve a relic intergranular texture are pseudomorphed by granoblastic plagioclase and pyroxene, respectively. The fact that these rocks retain their original textures and minerals may suggest they were deformed and recrystallized immediately following or during the late stages of emplacement. Thus, fabrics in these rocks may be igneous fabrics or accentuated igneous fabrics more related to emplacement processes than having a tectonic origin. Of note, Unit P_{MM} mzt (monzonite and syenite) rocks are unrecrystallized and appear undeformed. However, there are pervasively recrystallized and well-foliated Units P_{MM} mdq and P_{MM} gbr rocks that do not retain igneous textures; the fabrics in these rocks are interpreted as entirely tectonic. In addition, some Unit P_{MM} mdq rocks have a weak gneissosity, which is most easily interpreted as a thermotectonic feature.

Planar fabric elements, whatever their origin, are east-northeast to north-northeast striking in Units P_{MM} mdq and P_{MM} gbr (Figure 6). The age of the tectonic fabric is uncertain but presumed to be Labradorian. However, the fact that the southwestern part of the MMT, in NTS map area 13C/NE, includes an occurrence of foliated Pinwarian granite (unpublished U–Pb geochronological data), and that the late- to post-Grenvillian granite plutons have a local, weak foliation, leaves the possibility open that some fabrics in Units P_{MM} mdq and P_{MM} gbr are Pinwarian or Grenvillian.

In the southern domain, the K-feldspar porphyritic granite (Unit P_3 kpg) is extensively recrystallized, having augenitic to locally gneissic structure and a well-developed west-northwest-striking foliation that, in general, dips steeply to the north-northeast. Foliation is defined by recrystallized K-feldspar phenocrysts, biotite and hornblende. In marked contrast, the quartz monzonite (P_3 qmm) and gabbro (P_3 gbr) units are not as pervasively recrystallized or as well foliated as Unit P_3 kpg porphyritic granite. The quartz monzonite and gabbro are massive to foliated, mainly having west-southwest- to west-northwest-striking planar fabrics. The significant difference in strain between the units may indicate that intrusion of the quartz monzonite and gabbro largely postdated development of the strong foliation in the porphyritic granite. Tectonic fabrics in southern domain intrusive rocks are of undermined age.

Metasedimentary rocks (P_2 qtz), which occur as inclusions in Unit P_3 kpg porphyritic granite and Unit P_3 qmm quartz monzonite, are foliated and locally gneissic; pelitic rocks contain K-feldspar-bearing granitoid leucosome and the assemblage biotite + garnet + sillimanite ± cordierite. The ages of metamorphism and the structures in the metasedimentary rocks are undetermined but may be related to the same event that overprinted the Unit P_3 kpg porphyritic granite.

Two occurrences of mylonitic rocks at Fourmont Lake (see Figure 6), are inferred to define at least part of the contact between the northern and southern domains. (The nature of the domain boundary west of Fourmont Lake is uncertain because of lack of exposure, although it may be tectonic everywhere.) The southeastern occurrence of mylonites (Plate 12) forms a zone that is at least 75 m wide; the mylonites appear to be derived from K-feldspar porphyritic granite (Unit P_3 kpg). The highly strained rocks have a varied but mainly northwest-striking mylonitic planar fabric and a shallow, southeast-plunging mineral elongation lineation. Kinematic indicators were not observed. Granitoid

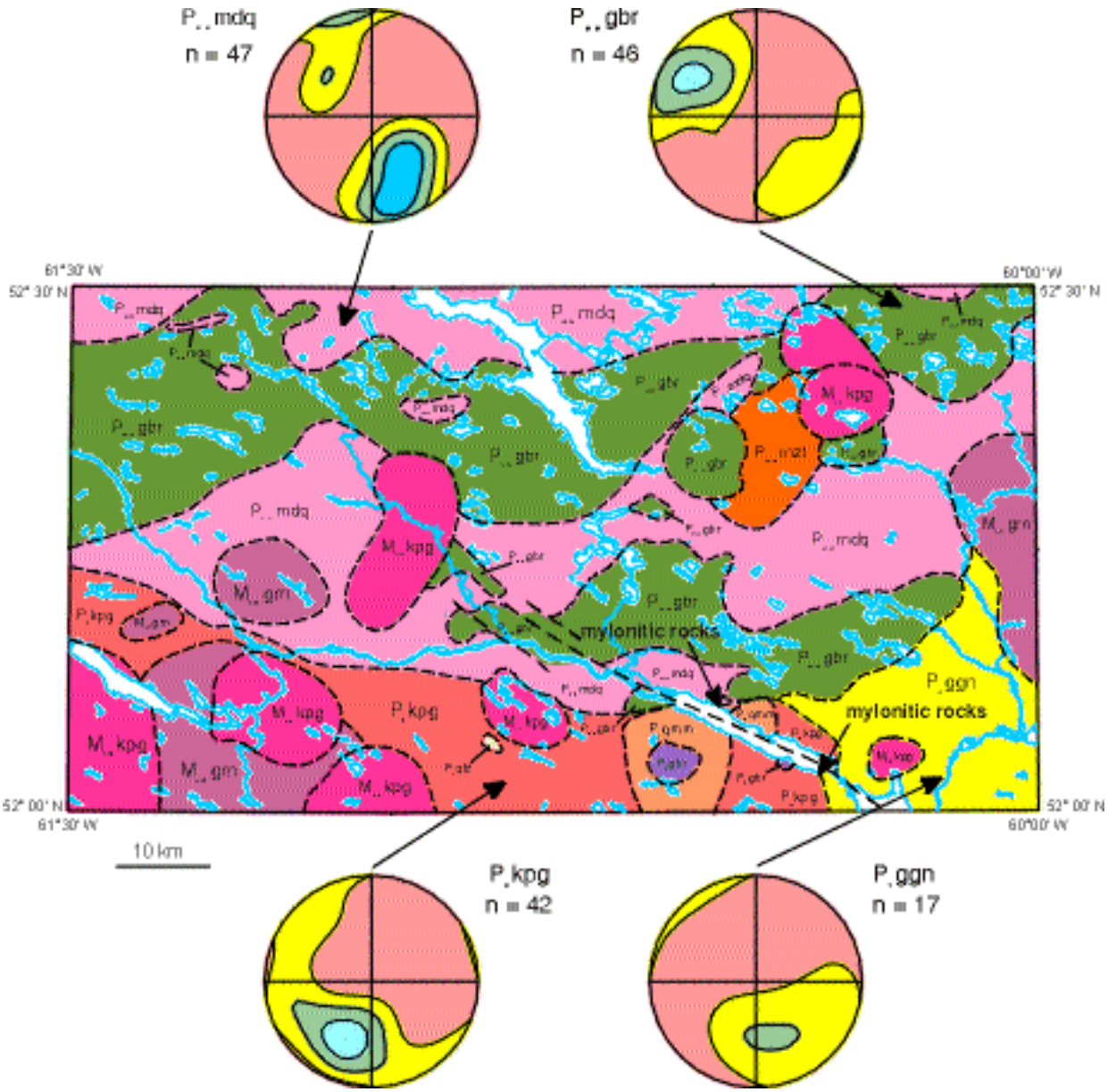

Figure 6. *Contoured, lower-hemisphere, equal-area projections of poles to planar-fabric elements in major rock units in the Minipi Lake study area.*

orthogneisses (Unit P_1 ggn), occurring 2 km southeast of the mylonitic rocks, are themselves highly strained; contained amphibolite layers are transposed and isoclinally folded about a strong, north-striking foliation (*see* Plate 2). The strength and attitude of the foliation is in marked contrast to the mainly northeast-striking gneissosity occurring elsewhere in Unit P_1 ggn orthogneiss. Indeed, on a much larger scale, the boundary separates the northern domain having mainly northeast-striking, Labradorian planar fabrics from the southern domain, which mainly has west-northwest- to west-southwest-striking (Mesoproterozoic?) planar fabrics.

Mylonitic and ultramylonitic rocks occurring along the domain boundary, near the northwest end of Fourmont Lake, appear to be derived from Unit P_1 ggn orthogneiss. The rocks have a west-northwest-striking planar fabric and a steeply plunging, east-southeast-trending mineral elongation lineation. Kinematic indicators were not observed.

In addition to the aforementioned occurrences of mylonitic rocks, minor shear zones, less than 20 cm wide and containing protomylonitic and mylonitic rocks, occur in P_3 qmm quartz monzonite on the north side of Fourmont

Lake (see Plate 9). The shear zones are west-striking and dip steeply to the north. A component of sinistral transcurrent strain is determined on the basis of C/S fabrics in the minor shear zones. These shear zones may be related to deformation along the domain boundary.

The full significance of the domain boundary remains to be determined, although based on the fact it separates different lithological domains containing different structures, and that it is marked by mylonitic rocks, it represents a major tectonic break defining the southern boundary of the Mealy Mountains terrane. The southern domain is of uncertain tectonic affinity although provisionally it correlates with the Mecatina domain. The age of deformation along the boundary is poorly constrained, although it must predate intrusion of the late- to post-Grenvillian granite plutons, which stitch the boundary. The domain boundary is inferred to be a Grenvillian structure although this model remains to be tested.

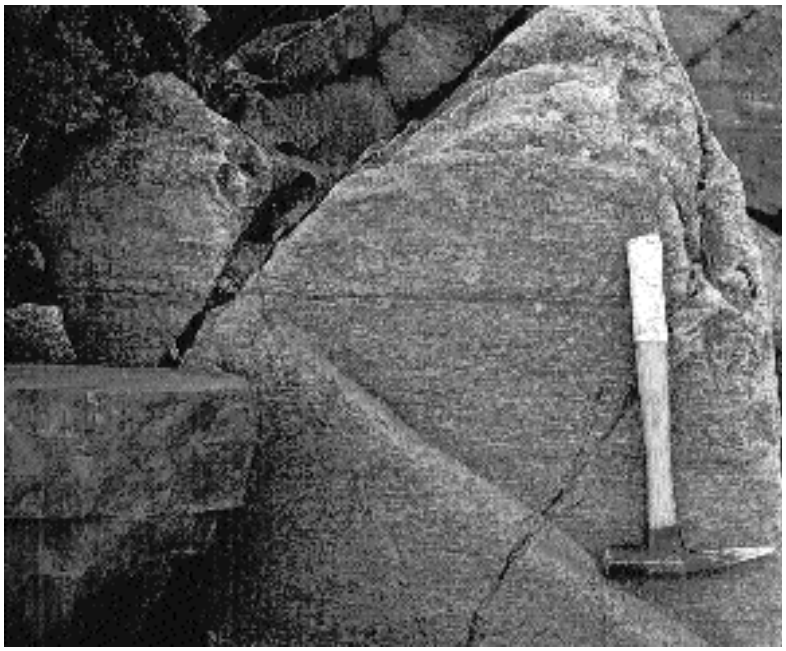

Plate 12. *Northwest-striking (Grenvillian?) mylonite containing a shallow, southeast-trending mineral elongation lineation. Textures suggest that the mylonite is derived from K-feldspar porphyritic granite (Unit P_3 kpg).* (Photo DJ-99-100)

EXPLORATION POTENTIAL

Field work in 1999 did not result in any significant or promising discoveries of economic minerals. However, the region, is underexplored and does have some exploration potential. For a wide-ranging discussion of exploration potential in the Grenville Province, metallogenic environments, a description of Baltic Shield metallogeny and relevance to the Grenville Province of northeastern Laurentia, the reader is referred to works by Swinden *et al.* (1991), Gower (1992), and Gower *et al.* (1995). A brief discussion of potential exploration targets in the Minipi Lake area, follows.

Mesoproterozoic and Paleoproterozoic anorthosite intrusions offer promising exploration targets for Ti (Fe) oxide and Ni–Co–Cu mineralization in the Grenville Province of southern Labrador. The QIT Fer et Titane Inc. Ti-deposits in Mesoproterozoic anorthosite near Harve-Saint-Pierre, Québec, provide the best local example of economic Ti-oxide mineralization in Grenville Province anorthosite. The area mapped in 1999 does not contain anorthosite, although there are major anorthosite occurrences in the MMIS, northeast of the study area (Gower, 1999; and *see* Wardle *et al.,* 1997). In addition, a cursory examination of Mecatina domain geology south of the Labrador–Québec border in 1999, revealed occurrences of anorthosite, approximately 20 km south of Fourmont Lake. In the next several years, mapping in the northwestern parts of the Mecatina domain (i.e., the western extension of the 1999 southern domain) in NTS map area 13D, may result in the discovery of hitherto unknown anorthosite intrusions. There may also be unmapped anorthosite intrusions, related to the Mesoproterozoic (ca. 1130 Ma) Atikonak anorthosite, in NTS map area 13D. The Atikonak anorthosite is approximately the same age as the Harve-Saint-Pierre intrusion, which hosts the QIT deposits.

Gabbro and gabbronorite intrusions in the map area, and elsewhere in the region, have some potential for hosting magmatic Ni-sulphide deposits. Several outcrops in the study area contain a few percent pyrite, although no significant sulphide occurrences were discovered. Supracrustal rocks (Unit P_2 qtz) may have some potential for base- and precious-metal mineralization. Potentially correlative rocks of the Wakeham Group, in the Wakeham terrane, host several mineral prospects and are the focus of ongoing exploration. For example, metasedimentary rocks in the Wakeham terrane contain anomalous gold mineralization associated with extensive tourmaline alteration in quartzite, and copper (massive-sulphide SEDEX) mineralization in pelitic metasedimentary rocks.

Granitic rocks may also be of some exploration interest. The extent of Pinwarian granitic magmatism in the area is uncertain, although anorogenic, Pinwarian-age granitic rocks in the St. Francois terrane of southeastern Missouri, host magmatic Cu–Fe mineralization. Also linked with this plutonism are polymetallic (Sn–W–Ag–Pb–As–Sb) quartz

veins. In Baltica, late- to post-Grenvillian granite plutons (e.g., in southwestern Norway) are associated with Mo mineralization and are locally anomalous in U and F. Also associated with these intrusions are fault-controlled polymetallic (Au–Ag–Cu–Pb–Zn) veins (*see* Gower, 1992). There is no known Mo mineralization in the late- to post-Grenvillian granite plutons in Labrador, although typically these intrusions are very poorly exposed and have not been mapped in any detail.

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