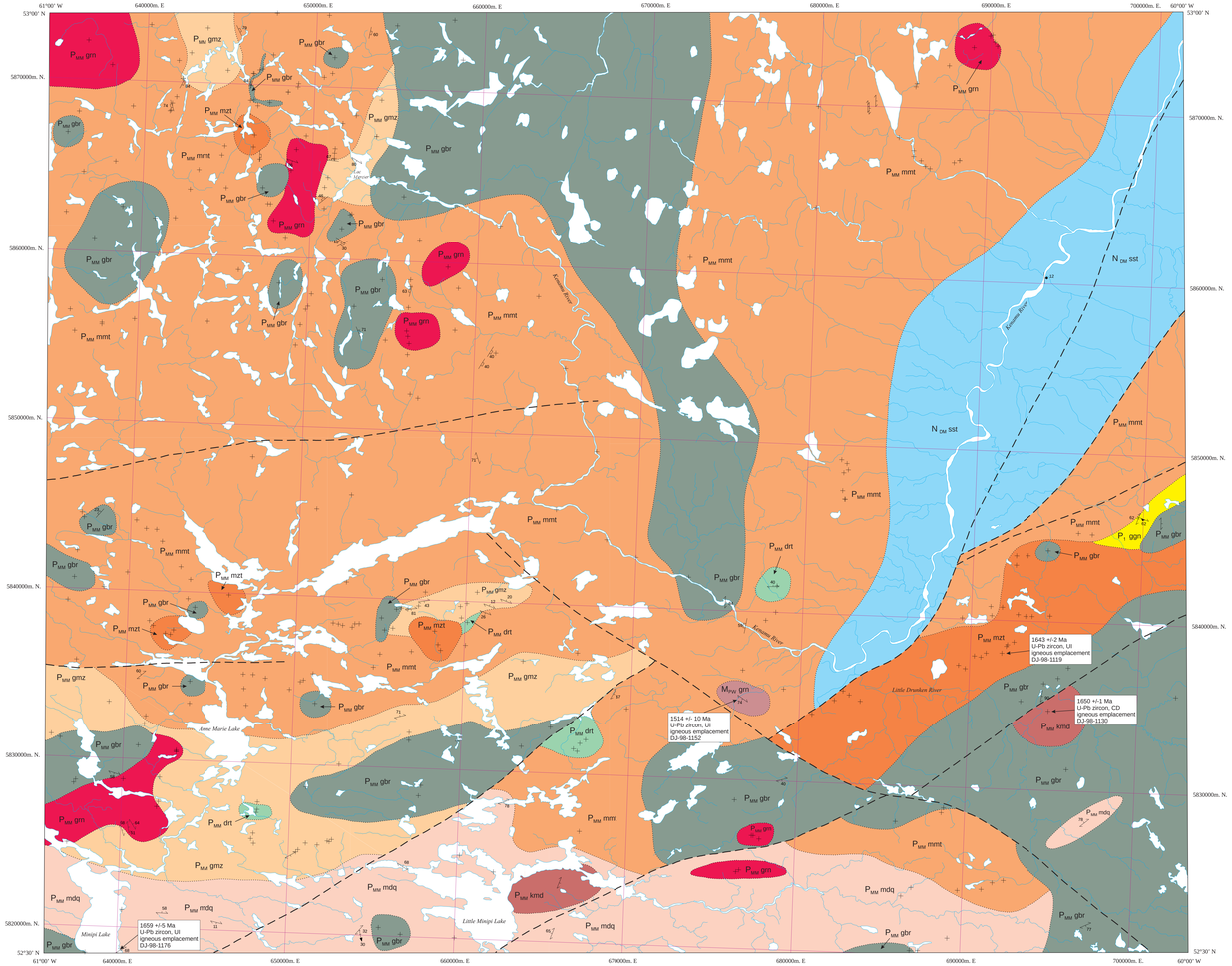

LEGEND

NEOPROTEROZOIC

Double Mer Formation: flat lying to gently east-dipping beds of mauve- to brown to dull red-weathering arkose, sandstone, and pebbly sandstone.

MESOPROTEROZOIC

Granite: pink weathering, foliated biotite monzogranite. U-Pb age: 1514 +/- 10 Ma.

PALEOPROTEROZOIC

Mealy Mountains intrusive suite

Gabbro - gabbronorite: unit consists mainly of fresh to variably deformed and metamorphosed gabbro and gabbronorite, but also includes minor amounts of leucogabbro, leucogabbronorite, diorite, olivine-bearing rocks, and amphibolite.

Diorite: flesh to variably deformed diorite and gabbro.

Quartz monzonite and granite: massive to foliated, fine- to medium-grained quartz monzonite and granite.

K-feldspar porphyritic monzonite: pink- to grey-weathering K-feldspar porphyritic or coarse-grained (isotropic) pyroxene-bearing monzonite. U-Pb age: 1643 +/-2 Ma.

Grey monzonite: grey-weathering, pyroxene-bearing monzonite; generally medium-grained but locally K-feldspar porphyritic, massive to foliated.

Monzonite: a heterogeneous division consisting mainly of pink- to grey-weathering, medium-grained pyroxene-bearing monzonite, but also includes porphyritic monzonite, and minor amounts of quartz monzonite and granite.

Quartz monzodiorite: white to grey to locally pink-weathering K-feldspar porphyritic quartz monzodiorite containing clinopyroxene and orthopyroxene. U-Pb age: 1650 +/-1 Ma.

Monzodiorite - diorite - monzonite: a heterogeneous division consisting of foliated to locally gneissic, pyroxene-bearing monzodiorite, diorite, monzonite, and containing minor amounts of foliated granite. In part the unit may contain more highly strained and recrystallized versions of all Mealy Mountains intrusive suite monzonitic and granitic rock types. U-Pb age: 1659 +/-5 Ma.

Gneissic rocks

Orthogneiss: pink-weathering granitic orthogneiss and migmatite.

- geological contact: assumed
- Neoproterozoic fault: assumed
- outcrop
- foliation (inclined, vertical)
- gneissosity (inclined, vertical)
- mineral elongation lineation
- bedding (tops known, tops unknown)
- igneous layering (tops known, tops unknown)

GEOCHRONOLOGICAL DATA

1659 +/-5 Ma
U-Pb zircon, UI
igneous emplacement
DJ-98-1176

age
isotopic system and mineral analysed, UI - upper intercept age, CD - concordant age
interpretation of age (in each sample, the age is interpreted as the time of igneous emplacement)
sample number

U-Pb geochronological analyses by S. Kamo and T. Krogh, Royal Ontario Museum, Toronto. Unpublished data, 1999.

Figure 2.

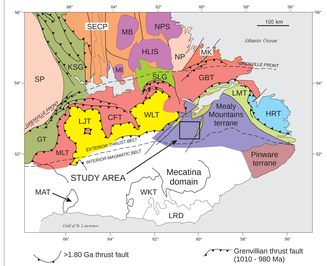

Figure 2. Location of the Kenamu River study area in relation to the tectonic and major lithotectonic units of northeastern Laurentia. Grenville Province: HRT - Hawke River terrane, LMT - Lake Melville terrane, GBT - Groswater Bay terrane, WLT - Wilson Lake terrane, CFT - Churchill Falls terrane, LJT - 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 - Kanaipiskau 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.

DATA POSITIONING

On this map, structural and outcrop data are plotted in the position where the data were collected in the field (i.e., symbols representing tectonic structures or primary features are not offset from the outcrop location). The centre of the symbol representing a planar fabric element (e.g., foliation or gneissosity) or a planar primary feature (e.g., bedding or igneous layering) is plotted in the position where the data were collected in the field. The + symbol represents an outcrop that has a massive (i.e., isotropic) structure or one that does not contain a measurable fabric (e.g., frost heave or an extensively fractured outcrop).

Data are plotted using a NAD 1927 projection, Grid Zone 20.

DESCRIPTIVE NOTES

INTRODUCTION

The geology of the Grenville Province south and southwest of Goose Bay, Labrador, including large parts of NTS map areas 13C and 13D (Figure 1), is known mainly 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, the northeastern quadrant of NTS map area 13C, including map sheets 13C/8, C/10, C/15 and C/16, were mapped at a scale of 1:100,000 in an eight-week field season in 1998. Mapping was mainly accomplished using ground traverses; survey crews were positioned by helicopter from a base camp at Brennan Lake, located 42 kilometres south of Goose Bay. Some of the mapping was completed by making helicopter landings on isolated outcrops. The work in 13C/NE was carried out simultaneously and in collaboration with 1:100,000-scale mapping in 13B/NW by Gower (1999). Preliminary findings of this project were reported by James and Lawlor (1999).

Bedrock in the study area is, in general, very poorly exposed, with the exception of the northwestern part of the study area (13C/15), and on hills south and west of the Kenamu River (southern part of 13C/16). The area is thickly forested or is covered by extensive areas of bog. Ground traversing is arduous and inefficient. Lakes and rivers are shallow, rocky, and are generally lacking in shore-line outcrops. Definitive contact relations between units were not observed. To some extent, the locations of contacts and faults shown on the geological map were interpreted using regional magnetic anomaly data.

REGIONAL SETTING

The study area is situated in the southwestern part of the Mealy Mountains terrane (MMT) (Gower and Owen, 1984) of the northeastern Grenville Province (Figures 2 and 3). The MMT consists primarily of Labradorian-age crust of the Mealy Mountains intrusive suite (MMIS) (*see* Emslie, 1976; Emslie and Hunt, 1990); minor amounts Paleoproterozoic pre-Labradorian crust, Pinwarian (1530-1450 Ma) and Grenvillian (ca. 980-950 Ma) intrusions (Krogh *et al.*, 1996). The MMIS mainly consists of an older group of anorthositic, leucogabbroic and leucotroctolitic rocks that occur in areas east of the study area (*see* Gower, 1999), and a younger group of pyroxene-bearing monzonite and quartz monzonite that dominate MMIS geology in the study area. 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 +/-22-9 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). The Labrador Orogen has a broadly tripartite zonation consisting of northern volcanic and sedimentary belts (e.g., Blueberry Lake and Bruce River groups), which were deposited on the southern margin of pre-Labradorian Laurentia, a medial magmatic zone defined as the Trans-Labrador batholith and interpreted as a subduction-related continental magmatic arc (*see* Kerr, 1989), and a southern zone dominated by paragneiss, orthogneiss and mafic intrusions (e.g., Ossok Mountain intrusive suite; James, 1994). The MMIS occurs within the southern zone.

The MMT is a Grenvillian tectonic unit and is one of the thrust-stacked terranes that make up the northeastern Grenville Province (Figure 2). The terrane straddles the boundary between the Interior Magmatic Belt and Exterior Thrust Belt (*see* Gower, 1996). The northeastern 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 25km east of the study area, is a Grenvillian tectonic contact (Gower, 1996). The MMT has been variably affected by Labradorian, Pinwarian, and Grenvillian (ca. 1000-950 Ma) tectonothermal events.

In the Kenamu River valley, the Paleoproterozoic igneous rocks are unconformably overlain by conglomerate, arkose and sandstone of the Neoproterozoic Double Mer Formation.

DESCRIPTION OF ROCK UNITS

P_{ggn}: Granitoid orthogneiss

Two outcrops of granitoid orthogneiss occur along the eastern margin of the map area and define unit P_{ggn}. The rocks are light pink to grey on the fresh and weathered surfaces. They are fine grained and granoblastic, having a gneissosity defined by alternating layers of leucogranite and grey-weathering granite containing <10% fine-grained biotite. These rocks do not contain pyroxene in contrast to the pyroxene-bearing gneissic rocks that are part of the MMIS (*see* unit P_{mm} mdq).

MEALY MOUNTAINS INTRUSIVE SUITE

P_{mm}mdq: Monzodiorite - diorite - monzonite

Unit P_{mm} mdq is a heterogeneous unit consisting of foliated to locally gneissic, pyroxene-bearing monzodiorite, diorite, monzonite and minor amounts of granite. The unit is very poorly exposed and contact relations between rock types were not observed in the field.

In the southwestern part of the study area, the unit mainly consists of monzodiorite and diorite. The rocks are white, grey and black on weathered surfaces, and white, grey, black and locally pink on fresh surfaces. They are medium- to fine-grained rocks having granoblastic textures; locally they contain a few percent relict K-feldspar phenocrysts. They consist of variable amounts of clinopyroxene (up to 15%), hornblende and biotite. Gneissosity is variably-developed and is defined by alternating layers, up to 20 cm thick, of leucocratic and melanocratic rocks. In some outcrops, mafic layers may represent pre-metamorphic mafic dykes. U-Pb analysis of zircons from a sample of gneissic monzodiorite, occurring at Minipi Lake, produced an age of 1659 ±5 Ma (unpublished data, 1999), interpreted to be age of emplacement.

In areas east of Little Minipi Lake, the unit mainly consists of pink- and grey-weathering monzonite and quartz monzonite. The rocks are variably foliated and recrystallized, and textures range from granoblastic to phanetitic. They are fine to medium grained, commonly have medium- to coarse-grained relict K-feldspar phenocrysts, and contain clinopyroxene, magnetite, and local, minor amounts of biotite. Typically, outcrops have a homogeneous texture and composition, and do not contain inclusions or dykes.

Unit P_{mm} mdq also includes minor amounts of foliated granite. The rocks are pink to grey on weathered surfaces and pink on fresh surfaces. Rocks are medium to fine grained, variably foliated and recrystallized, and textures range from granoblastic to phanetitic. Medium- to coarse-grained K-feldspar phenocryst relicts occur locally. The rocks contain minor amounts of biotite.

P_{mm}kmd: Quartz monzodiorite

The southern part of the study area includes two bodies of K-feldspar megacrystic quartz monzodiorite. There are few outcrops of this unit and contacts that define the bodies are very poorly constrained; the easternmost body is defined by only one outcrop.

The quartz monzodiorite is white to grey to locally pink on the weathered surface, and grey and pink on the fresh surface. Rocks contain 10 to 15 %, medium- to coarse-grained (to 1.5 cm) subhedral K-feldspar phenocrysts in a finer grained groundmass consisting of plagioclase, quartz, and minor amounts of clinopyroxene, biotite and magnetite. All rocks are variably recrystallized and weakly foliated. The foliation is defined by biotite, and locally by alignment of the K-feldspar phenocrysts. Preferred orientation of the phenocrysts may be a relict primary igneous lamination. Locally, outcrops contain abundant, thin (<10 cm) and undeformed granitic veins, and gabbro xenoliths. U-Pb analysis of zircons from a sample of the unit produced an age of 1650 +1 Ma (unpublished data, 1999), interpreted to be age of emplacement.

P_{mm}mmt, P_{mm}gmz, P_{mm}mzt: Monzonite

The study area is dominated by three units of monzonitic rocks that make up part of a >3500 km^2 monzonite-dominated zone comprising the western part of the MMIS. In the field, monzonitic rocks have been subdivided on the basis of colour and texture. These units, consisting mainly of pink-weathering monzonite (P_{mm} mmt), grey-weathering monzonite (P_{mm} gmz), and K-feldspar porphyritic monzonite (P_{mm} mzt) are defined. However, each of the units is a heterogeneous division, particularly unit P_{mm} mmt, and they each contain lesser amounts of the other rock types. Contacts are drawn on the map to define areas consisting mainly of one rock type. The contacts should not be interpreted to outline individual intrusions; thus they are of limited value. Furthermore, each of the monzonite units contains minor amounts of quartz monzonite and monzogranite. It is uncertain if the quartz-bearing rocks represent separate intrusions or are minor and local compositional variations of the monzonitic rocks. U-Pb analysis of zircons from a sample of undeformed, grey-weathering, K-feldspar porphyritic monzonite (P_{mm} mzt) produced an age of 1643 ±2 Ma (unpublished data, 1999), interpreted to be age of emplacement.

The three units have similar compositions, and in general, have remarkably monotonous compositions over very large areas. However, the units are texturally varied and can be uniformly fine to coarse grained (to 1.5 cm), or K-feldspar porphyritic; they can have subhedral granular to recrystallized or granoblastic textures. In the northern two-thirds of the study area, the rocks are mainly undeformed and have fresh, phanetitic textures. In contrast, rocks in the southern part of the area are variably foliated and recrystallized. Locally, the rocks have an igneous layering, defined primarily by thin (<1 cm) concentrations of magnetite. Some of the rocks have an igneous lamination defined by alignment of K-feldspar phenocrysts. The monzonitic rocks contain up to 15 % (combined), fine- to medium-grained clinopyroxene, orthopyroxene, and magnetite. Orthopyroxene is not present in all rocks. Magnetite is ubiquitous and the units are marked by a prominent regional magnetic high.

P_{mm}gmz: Quartz monzonite and granite

Several small bodies of quartz monzonite and granite have been defined at the current level of mapping. In general, the rocks are light pink on the fresh and weathered surfaces, fine to medium grained and equigranular. They contain local, minor amounts of clinopyroxene, biotite and, commonly, several percent magnetite. The rocks in the northern part of the study area are massive and unrecrystallized, whereas in the southern part of the study area they are typically foliated and recrystallized.

P_{mm}gbr and P_{mm}drt: Gabbro-gabbronorite and diorite

In the study area, intrusions of gabbro-gabbronorite (P_{mm} gbr) and related diorite (P_{mm} drt) make up a subordinate amount of the MMIS, as compared to the monzonitic rocks. The mafic intrusions are inferred to intrude the monzonitic and granitic rocks, although definitive contact relations were not observed. There are local occurrences of gabbro and gabbronorite dykes, which are intrusive into the MMIS monzonitic rocks, although correlation of the dykes with the map-scale units of P_{mm} gbr rocks is uncertain.

As with all rock units mapped in the study area, the contacts defining P_{mm} gbr and P_{mm} drt bodies are poorly constrained. Of particular note, the 35-km long, north-trending body of P_{mm} gbr in the central part of the study area is very poorly exposed; the area is covered by a vast region of string bogs. P_{mm} gbr rocks in the southeastern corner of the study area are also poorly exposed; the area is relatively flat and covered by extensive deposits of Quaternary sand. Contacts defining P_{mm} gbr rocks in both of these areas are largely inferred from magnetic anomaly maps. In general, P_{mm} gbr rocks are less magnetic and have a lower magnetic signature than the monzonitic and granitic rocks.

Unit P_{mm} gbr consists mainly of gabbro and gabbronorite, but also includes minor amounts of leucogabbro, leucogabbronorite, and rare olivine-bearing rocks. Similar to the regional textural variations observed in the monzonitic rocks, P_{mm} gbr rocks in the northern two-thirds of the study area have mainly preserved igneous textures, whereas in the southern part of the area, rocks are more pervasively recrystallized and foliated. In northern area, rocks are medium grained and have subophitic granular or intergranular textures. Plagioclase grains are mainly equant as opposed to having a lath habit. Rocks are variably recrystallized, plagioclase grains are locally pseudomorphed by granoblastic plagioclase aggregates, but in general, rocks do not contain tectonic fabrics. Igneous layering, defined by alternating plagioclase-rich and pyroxene-rich layers occurs locally.

In the southeastern corner of the study area, and in the area east of Anne Marie Lake, unit P_{mm} gbr consists of metamorphosed gabbro, gabbronorite and lesser leucogabbronorite. It also includes a minor amount of amphibolite, which is presumed to be a more extensively recrystallized and metamorphosed version of P_{mm} gbr rocks occurring elsewhere. In general, rocks in the southern part of the study area are medium grained and have granoblastic, metamorphic textures. They are variably foliated, and are locally massive. They consist of variable amounts of plagioclase, clinopyroxene, hornblende, and local, minor amounts of orthopyroxene. Biotite is a common accessory mineral and some rocks contain a minor amount (<10%) of K-feldspar. Trace amounts of disseminated pyrite occur locally.

MESOPROTEROZOIC INTRUSIONS

M_{mz}grn: Granite

Several, closely spaced outcrops of foliated granite, covering an area of approximately 0.5 km^2, make up the M_{mz} grn unit. The contacts surrounding the unit, as shown on the map, are drawn with very little confidence, and the unit is of uncertain size. The granite is medium pink on fresh and weathered surfaces. It is fine to medium grained, well foliated and extensively recrystallized. It consists of microcline, more than 25 % quartz, and minor amounts of plagioclase and biotite (<5%). Rocks contain a minor amount of secondary chlorite and epidote. In contrast to granitic rocks in the MMIS, the M_{mz} grn granite contains abundant quartz. U-Pb analysis of zircons from a sample of the unit produced an age of 1514 ±10 Ma (unpublished data, 1999), interpreted to be age of emplacement. The strong foliation in this granite demonstrates that this region must have been overprinted by Pinwarian or Grenvillian deformation.

Mafic Dykes

Minor occurrences of unmetamorphosed and undeformed mafic dykes, too small to be shown on the map, occur throughout the study area. Northeast- to east-northeast-striking dykes, having an ophitic texture and containing fine- to medium-grained blalded and fork-shaped plagioclase grains, are inferred to be part of the ca. 1250 Ma Mealy dyke swarm (e.g., UTM 637867E, 5855764N; and *see* Hamilton and Emslie, 1997). North-northeast-striking dykes may be equivalent to the ca. 615 Ma Long Range Dykes (*see* Kamo *et al.*, 1989).

NEOPROTEROZOIC

N_{dm}sst: Double Mer Formation

Paleoproterozoic to Neoproterozoic igneous rocks in the study area are unconformably overlain by the Neoproterozoic Double Mer Formation (*see* Kindle, 1924; Gower *et al.*, 1986). The Double Mer Formation was not a focus of the mapping and only a few exposures were given a cursory examination. Along the Kenamu River, in NTS map area 13C/16, the formation consists of flat lying to gently east-dipping beds of mauve- to brown- to dull red-weathering arkose, sandstone, and pebbly sandstone. Quartz, K-feldspar and lithic (monzonite) clasts are angular to rounded. Some pebble-size clasts are coarse-grained K-feldspar grains derived from individual phenocrysts. The clast population indicates detritus is primarily derived from proximal MMIS monzonitic rocks.

METAMORPHISM and STRUCTURE

Paleoproterozoic and M_{mz} grn units occurring in the southern part of the study area are commonly foliated, locally gneissic, and variably recrystallized. Foliation is defined by alignment of recrystallized feldspar, pyroxene and quartz aggregates, and locally, biotite. In most outcrops the foliation is a tectonic fabric, and the recrystallization and development of gneissosity are unequivocally metamorphic features. However, in some MMIS rocks, the foliation may be a relict or modified igneous fabric related to pluton emplacement. East of Anne Marie Lake, foliation and gneissosity are mainly east-northeast striking. In the Minipi Lake and Anne Marie Lake area, tectonic fabrics are mainly northwest striking. The recrystallized rocks contain clinopyroxene and local orthopyroxene that are variably overprinted by amphibole and biotite. The mineral textures and local development of gneissosity suggest recrystallization occurred at amphibolite- to upper-amphibolite-facies conditions.

Age(s) of deformation and metamorphism are undetermined. The fact that emplacement ages for samples of deformed and recrystallized rocks from units P_{mm} mdq (a monzodiorite gneiss) and P_{mm} kmd (a foliated quartz monzodiorite) pre-date 1643 ±2 Ma emplacement of an undeformed K-feldspar porphyritic monzonite from unit P_{mm} mzt, may indicate that some MMIS rocks were overprinted by an event constrained to be between 1650 and 1643 Ma. However, the fact that the M_{mz} grn granite, having an emplacement age of 1514 ±10 Ma, is strongly foliated indicates the area must have been overprinted by Pinwarian and/or Grenvillian deformation. These data allow for several possible scenarios, including 1) that the area contains pre-1643 Ma (Labradorian) structures and post-1514 Ma (either Pinwarian or Grenvillian) structures, or 2) that all tectonic structures are post-1514 Ma, and are either Pinwarian or Grenvillian.

In either of the above scenarios it is necessary for some MMIS rocks to escape deformation. The distribution of strain is heterogeneous in MMIS rocks from the map scale to the outcrop scale, although undeformed MMIS rocks occur mainly, but not exclusively, in the northern part of the study area. There is no well-defined "structural front" that separates regions of deformed and undeformed rocks. Significant variations in strain and degree of recrystallization in MMIS rocks are, in some instances, very local and occur over several metres. These local variations cannot easily be explained by a simple model involving MMIS intrusions of several ages that predate and postdate a Labradorian deformation. Rather, local strain variations may be influenced by original textures or variations in grain size. Coarse-grained, isotropic rocks, for example, may be less amenable to developing a tectonic foliation as compared to finer grained rocks containing an original igneous lamination. Detailed geochronological studies will be necessary to resolve this problem and refine tectonic models for the region.

The study area is dissected by regionally persistent southwest-, west- and northwest-striking Neoproterozoic faults. The faults are not exposed; they are recognized mainly by lineaments in the magnetic anomaly pattern and by topographic lineaments. An outcrop of MMIS monzonite occurring along the Kenamu River (UTM 676658E, 5839131N) contains thin (<1 m wide) breccia zones (orientation: 230°/88° NW) consisting of angular monzonite fragments (to 10 cm) and extremely fine-grained matrix. The brecciation in this outcrop may be related to the southwest-striking faults. The southwest-striking faults are presumed to be normal faults defining half-grabens structures that controlled deposition of the Double Mer Formation (Gower *et al.*, 1986). The Neoproterozoic faulting is inferred to be related to the opening of Iapetus.

EXPLORATION POTENTIAL

Field work in 1998 did not result in any significant or promising discoveries of economic minerals. However, the region, which includes the study area, is under-explored and does have some exploration potential. For a discussion of exploration potential in the northeastern 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 Gower *et al.* (1991), Gower (1992), and Gower *et al.* (1995). A brief discussion of potential exploration targets in the Minipi Lake area (NTS 13C), is included in James and Nadeau (2000).

In the study area, MMIS gabbro and gabbronorite intrusions 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.

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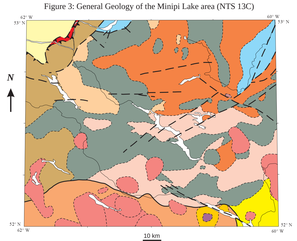
Figure 3: General Geology of the Minipi Lake area (NTS 13C)



Sources: 13C/NW: Wardle et al. (1990), 13C/NE: James and Lawlor (1999), 13C/S: James and Nadeau (2000).

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Geology by D.T. James and B. Lawlor, 1998.

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This map represents a preliminary interpretation of the geological field data and is subject to change without notice. Comments regarding revisions or errors are invited and should be directed to the Director, Geological Survey of Newfoundland and Labrador, P.O. Box 8700, St. John's, Newfoundland. A1B 4J6

GEOLOGY

OPEN FILE 013C/0040
MAP 99-13

GEOLOGY OF THE KENAMU RIVER AREA (NTS 13C/NE), GRENVILLE PROVINCE, SOUTHERN LABRADOR.

Scale: 1:100 000

0 1 2 3 4 5 10
kilometres

Figure 1.

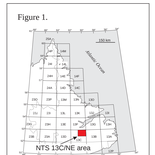

Figure 1. Index map of Labrador showing location of the study area.