Current Research (1996) Newfoundland Department of Natural Resources, Geological Survey, Report 96-1, pages 55-71

GEOLOGY OF THE SOUTHEAST MEALY MOUNTAINS REGION, GRENVILLE PROVINCE, SOUTHEAST LABRADOR

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ABSTRACT

The southeast Mealy Mountains map region is divided into two parts. The eastern part is underlain by gneisses and moderately to strongly foliated granitoid rocks that are probably early Labradorian or older (i.e., pre-1665 Ma). The western part is underlain by the 1646- to 1635-Ma Mealy Mountains Intrusive Suite (MMIS).

Orthogneisses and metasedimentary gneisses are present in the east. The orthogneisses are mainly biotite-bearing granodioritic gneiss, with lesser granitic, quartz dioritic, dioritic and K-feldspar augen gneiss. The metasedimentary gneisses are mostly pelitic, but minor psammitic, calc-silicate and quartzitic rocks are present. Sillimanite, garnet, cordierite or orthopyroxene are observed in various places in the pelitic gneiss.

Deformed granitoid rocks in the east comprise hornblende- and biotite-bearing granitoid plutons, some of which have K-feldspar megacrysts. Both the gneisses and granitoid rocks contain amphibolite bodies representing remnants of mafic dykes. Locally, discordant intrusive contacts are preserved. Foliated granitoid rocks are also present in the southwest part of the study area, but have not been assigned to any established group.

The MMIS in the west consists mostly of monzonitic rocks belonging to one plutonic body having a border of granite to quartz monzonite, grading inward through even-textured monzonite into K-feldspar megacrystic monzonite. Monzonite in the southwest is texturally distinct and is considered to be a separate body. Two satellite monzonite plutons intrude metasedimentary gneisses. The larger body (previously dated to be 1646 ± 2 Ma) has a narrow rim of leucogabbronorite, and monzonorite in its centre. Similar monzonorite, within the main mass of monzonite, farther southwest may indicate a small pluton in that area. Leucotroctolite and leuconorite were mapped in the northwest and appear to form a domal structure, on the basis of layering seen in several places.

East-northeast-trending Mealy dykes (ca. 1380 Ma) are particularly common in the northwest part of the MMIS, but also occur farther south, and within the metasedimentary gneisses to the east. A north-northeast-trending brittle fault in the southeast is linked to ca. 615-Ma rifting.

INTRODUCTION

The southeast Mealy Mountains map region is located in the Grenville Province in eastern Labrador (Figure 1). It includes 1:50 000-scale NTS map areas 13G/01, 13G/02, 13G/07 and 13G/08 (NTS 13G/southeast), collectively embracing an area of about 3,700 km^2. Mapping in the region was undertaken as part of the Newfoundland Department of Natural Resources continuing program of geological reconnaissance mapping in Labrador.

The northwest part of the region is a barren or sparsely vegetated upland to mountainous region forming the southeastern flank of the Mealy Mountains. Many of the hills exceed 600 m elevation and the highest point is over 820 m. The topography in the upland area is controlled by east-northeast- and north-northwest-trending fracture sets, which are most prominent in northern and westernmost districts. The region grades into lower, wooded hills to the south and east. The highest areas in the map region coincide with monzonitic bedrock of the Mealy Mountains Intrusive Suite (MMIS) and, as a first approximation, the edge of the hills defines the eastern margin of the MMIS. Exposure varies from excellent in the northwest to poor in the southern wooded areas.

The eastern lowlands consist of gently rounded, wooded

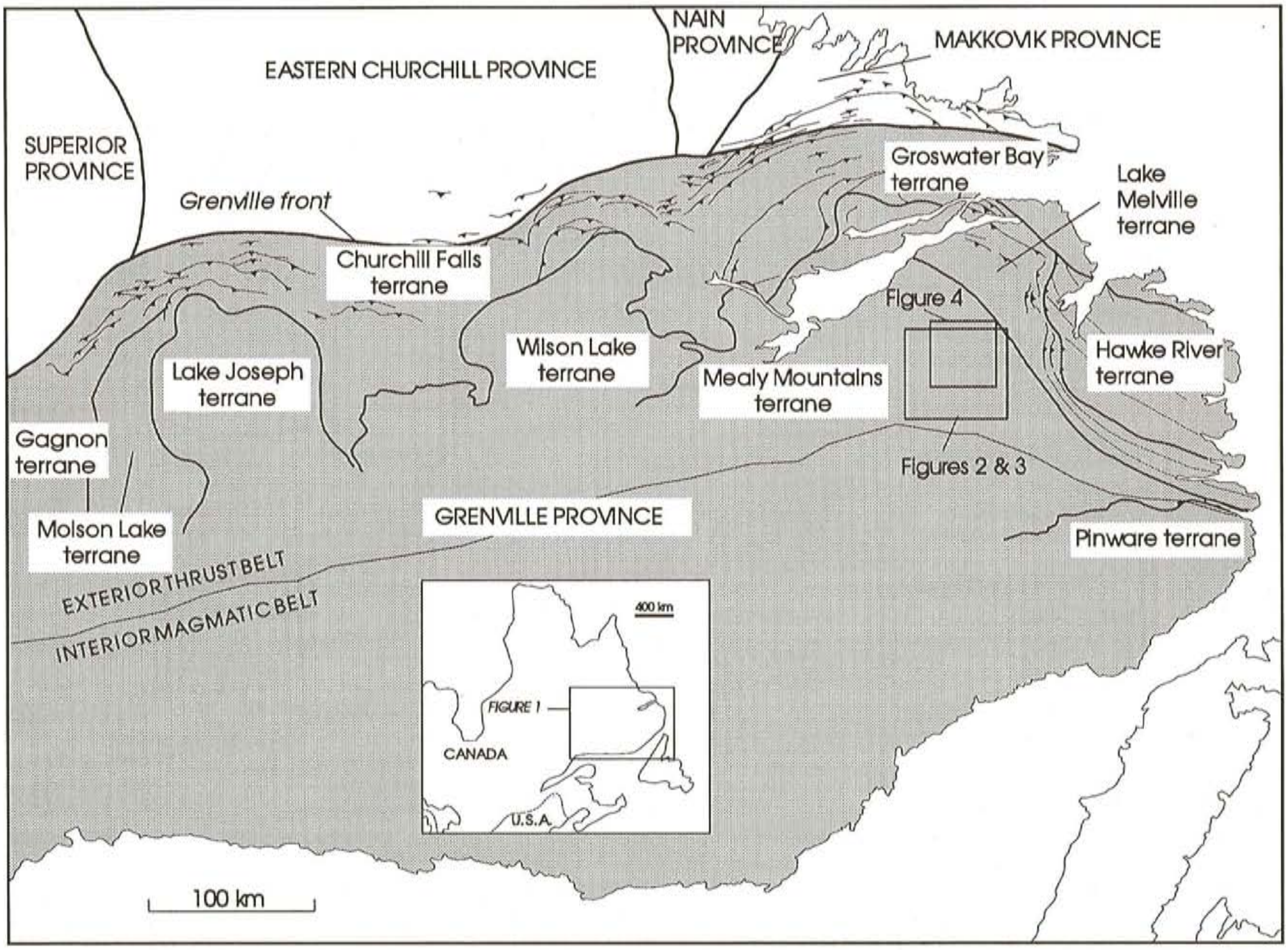

Figure 1. *Location of the southeast Mealy Mountains map region with respect to major structural features of the eastern Grenville Province.*

hills interspersed with open wetland and underlain by gneisses. Bedrock in these areas is blanketed by fluvioglacial deposits, which include some prominent northeast-trending eskers. Rock exposures are most common at the edge of incised streams and on the tops of low hills, but are also found sporadically at the margins of lakes or marshy areas. In the southeast, the deeply incised Eagle River and its tributaries form an impressive gorge, but the steep, wooded sides of the gorge makes much of the riverside exposure somewhat inaccessible, except by rapids-running boats.

During the present mapping, 575 data stations were established and samples collected from most of them. The number of data stations is lower than for similarly mapped areas elsewhere in eastern Labrador, but, given the poorly exposed eastern portion and the relative homogeneity of rocks in the MMIS, it is arguable whether the map would have been greatly improved had more resources been devoted to it. Dr. R.F. Emslie kindly made his 1975 field notes available to this project and information from them, and data stations established by Eade (1962), have been integrated into the map and text. All samples collected during the present mapping have been slabbed and stained (for potassium-bearing minerals); rock descriptions given below incorporate information from stained slabs.

PREVIOUS WORK

The bipartite division between MMIS in the west and older gneisses in the east is evident in the map of Eade (1962), who shows the western half of the region to be underlain by monzonite, anorthosite and related rocks (his Units 5 and 6), and the eastern half to comprise granitic gneiss and associated rocks (his Unit 3). Emslie (1976, and an unpublished 1:250 000-scale map; R. Emslie, personal communication, 1994) refined both the distribution and terminology of the MMIS. The essential elements of the 1:250 000-scale map have been published by Emslie *et al.* (1984; their Figure 2). Within the present study area, significant changes made by Emslie with respect to the map of Eade include considerably enlarging an area of anorthosite and related rocks, redefining it as leucotroctolite, and showing east-northeast-trending mafic dykes. Emslie's (1976) report, albeit brief, remains the most comprehensive descriptive account of the MMIS currently available. Most of his report was based on work that was carried out farther to the west and north, and only a few data stations were established in NTS map area 13G/southeast.

Several publications, although not specific to the region considered here, have addressed various aspects of the geology of the MMIS. Information concerning isotopic characteristics of the anorthositic rocks was presented by Ashwal *et al.* (1986). The U – Pb zircon dates for two rocks of the MMIS (1645.5 ± 1.5 Ma for a pyroxene monzonite within the study area and 1635 $^{+22}_{-8}$ Ma for a pyroxene granite from eastern Lake Melville) have been reported by Emslie and Hunt (1990). The location of the 1645.5 ± 1.5-Ma date is indicated in Figure 2. A Rb – Sr age of 1678 ± 77 Ma from monzonite-granite is reported by Emslie *et al.* (1983). Data pertinent to the chemistry of major mineral phases in anorthosite of the MMIS are diagrammatically summarized in a general paper on Proterozoic anorthosite massifs by Emslie (1985).

The name, Mealy dykes, for a suite of east-northeast-trending olivine tholeiitic dykes was introduced by Emslie *et al.* (1983), who reported a whole-rock Rb – Sr (errorchron) age of 1380 ± 54 Ma for the dykes. In the same year, Park and Emslie (1983) published results of a paleomagnetic study on the Mealy dykes (north of the present study area). The petrology, age and tectonic significance of the Mealy dykes has been discussed by Emslie *et al.* (1984), again drawing on samples north of the present area. Emslie *et al.* (1984) include whole-rock and mineral geochemical data and full details of the 1380-Ma Rb – Sr errorchron age. Other geochronological data for the Mealy dykes has been published by Gittins (1972) and Reynolds (1989). Gittins (*op. cit.*) determined K – Ar whole-rock ages of ca. 1100 Ma and Reynolds (1989) concluded that an amphibole plateau age of ca. 1215 Ma may approximate the age of intrusions. The whole-rock geochemical compositions of the Mealy dykes were compared and/or contrasted with other Mesoproterozoic mafic intrusive suites in Labrador by Gower *et al.* (1990).

Geological mapping at 1:100 000 scale has been carried out by the Newfoundland Department of Natural Resources to the northeast, east and southeast (Gower *et al.*, 1983; Gower *et al.*, 1986; van Nostrand, 1992), and to the west (Nunn and van Nostrand, *this volume*). Areas to the north and northwest have been mapped by Emslie (1976; R. Emslie, personal communication, 1995). The regions to the south and southwest remain unmapped. Aeromagnetic coverage of the region is available at 1:250 000 and 1:63 360 scales as uncoloured maps (Geological Survey of Canada, 1974a and b; 1976a,b and c), 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 Geological Survey of Canada data are available at 1:250 000 and 1:100 000 scale from the Newfoundland Department of Natural Resources (cf. Figure 3). The study area is also included as part of the 1:500 000 Bouguer anomaly map for Battle Harbour – Cartwright (Thomas, 1974), and the regional lake-sediment and geochemical survey for NTS map area 13G (Friske *et al.*, 1992).

Very little mineral exploration activity has been reported for the Mealy Mountains, and that carried out makes only passing reference to NTS map area 13G/southeast. An airborne magnetometer survey was undertaken in the early 1950s by Frosbisher Limited in the eastern Mealy Mountains (Evans, 1951), which included the northwestern part of the present map region, but no follow-up work was carried out in the area. Elsewhere in the Mealy Mountains, several magnetic anomalies were investigated by Frobisher Limited and NALCO, and concentrations of titaniferous magnetite were discovered. None were deemed to have economic potential and work ceased.

REGIONAL GEOLOGICAL SETTING AND MAJOR UNITS WITHIN THE MAP REGION

The region is situated within the Mealy Mountains terrane in the Exterior Thrust Belt in the eastern Grenville Province (Figure 1), except for the northeasternmost corner, which belongs to the Lake Melville terrane.

Rocks in the region can be divided into two main groups, namely: i) gneissic and granitoid rocks and minor mafic units in the east, and ii) anorthositic and monzonitic rocks forming the MMIS in the west. The gneissic rocks can be subdivided into those interpreted to have been derived from meta-sedimentary protoliths versus those considered to be of igneous origin.

METASEDIMENTARY GNEISS

Metasedimentary gneiss underlies about 25 percent of the map region (Figure 2), forming continuations of similar rocks mapped to the north (Gower *et al.*, 1983) and east (Gower *et al.*, 1986). Exposure is very poor in the east, but improves as the MMIS is approached.

Metasedimentary gneiss in the eastern part of the map region (in the southeast tongue and for 5 to 8 km west of the eastern granitoid plutons) is mainly well-banded (locally mylonitic) pelitic gneiss consisting of black or grey, 1- to 5-

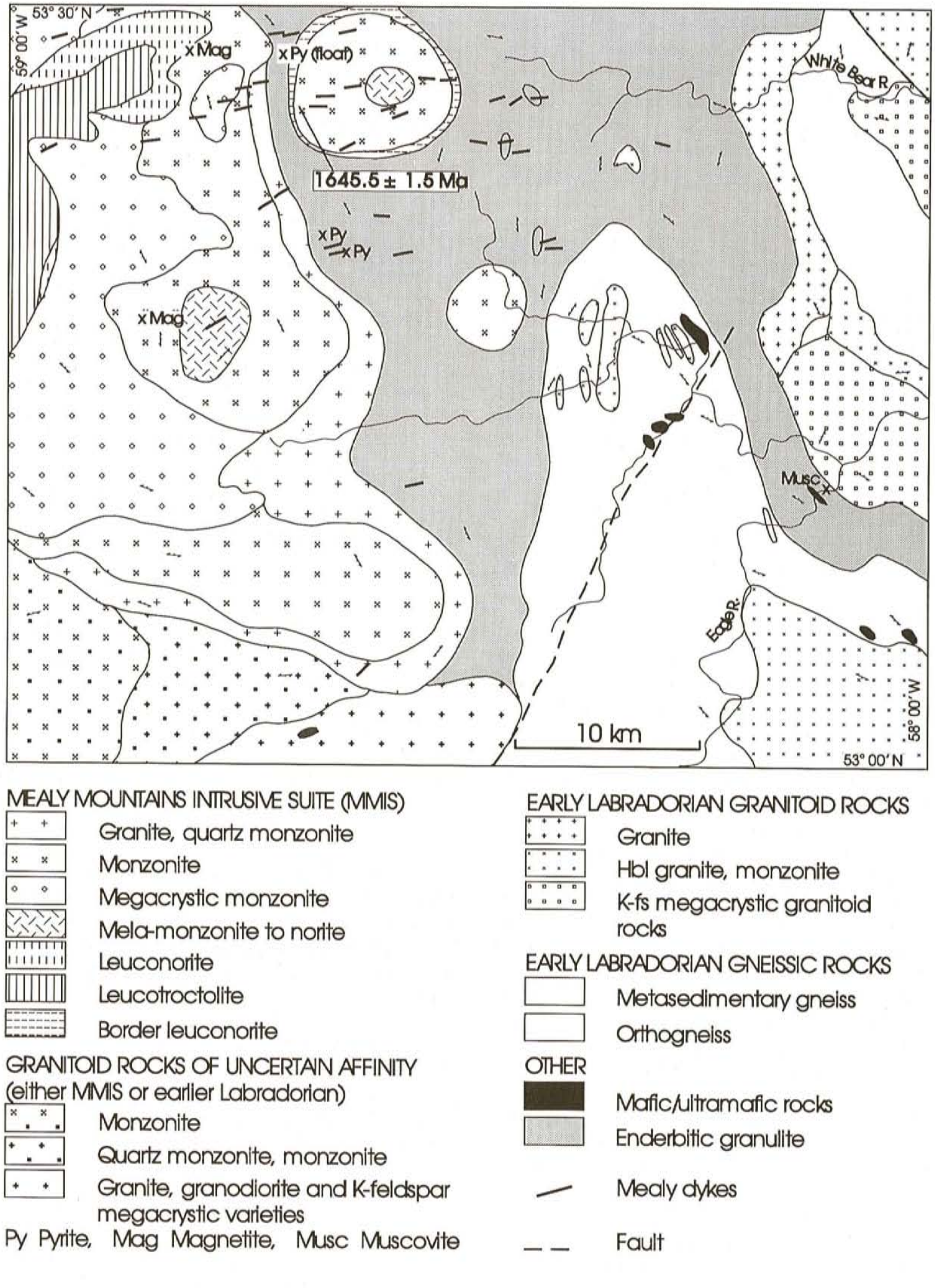

Figure 2. *Simplified geological map of the southeast Mealy Mountains map region (NTS 13G/southeast).*

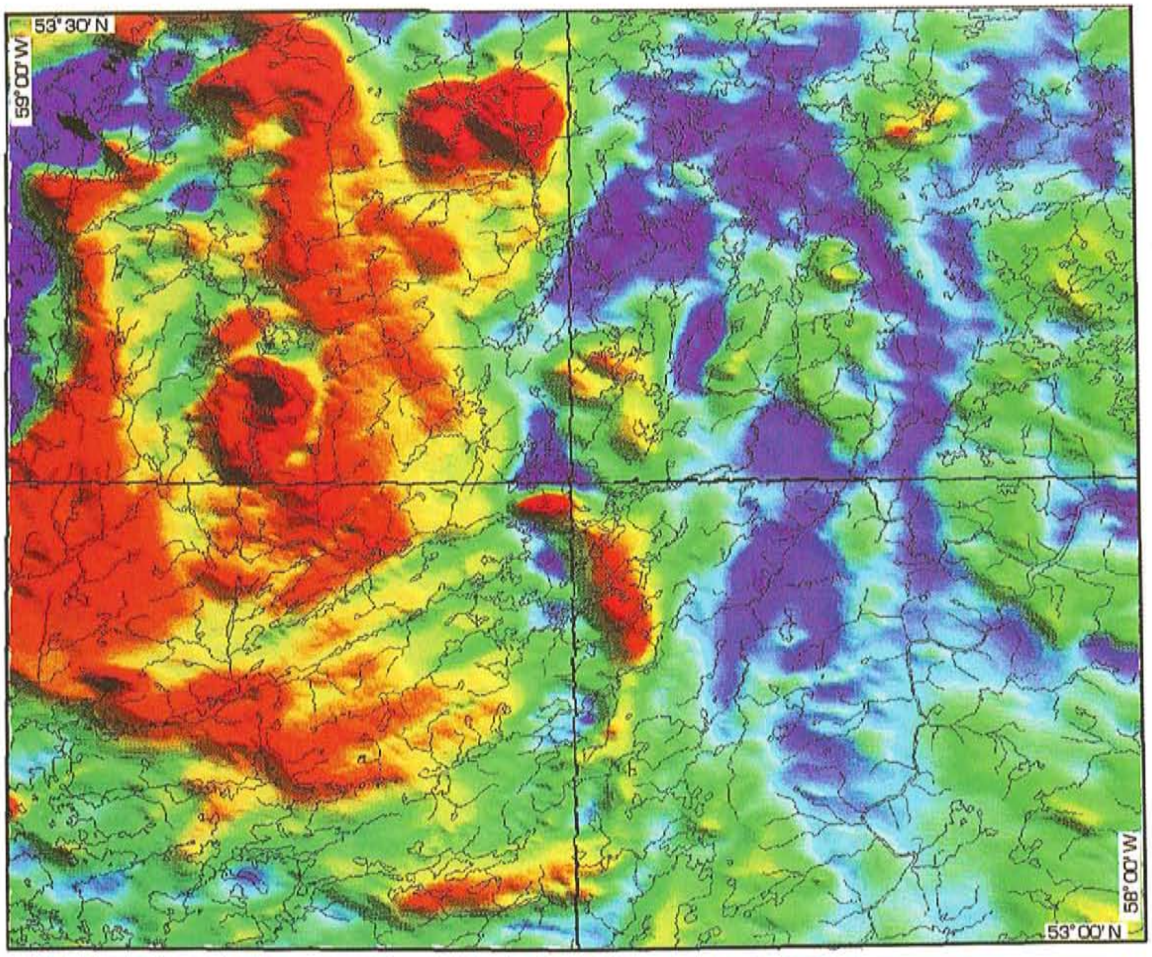

Figure 3. *Coloured shaped-relief aeromagnetic map of NTS map area 13G/southeast. Red end of spectrum - magnetic highs; blue end of spectrum - magnetic lows; map prepared by G. Kilfoil.*

mm-wide, schlieric sillimanite – garnet – biotite ± muscovite melanosome and 10- to 50-cm-wide irregular layers of creamy-white or pink K-feldspar – plagioclase – quartz ± garnet leucosome (Plate 1). Garnet (mauve to wine red) is very abundant, in some layers making up to 30 percent of the rock. It forms grains commonly about 1 cm across, but locally up to 6 cm in diameter. Typically, it is partially retrograded and also occurs as elliptical aggregates elongated in the plane of the gneissosity. Associated rocks include garnet – biotite psammitic gneiss with more diffuse and irregular leucosome, minor quartzite, rare calc-silicate gneiss and medium-grained amphibolitic pods and layers. Gneissosity in the metasedimentary gneisses is discordantly intruded by pegmatite dykes, veins and pods that are themselves deformed. Some of the pegmatites contain abundant muscovite (see section on Economic Potential, page 69).

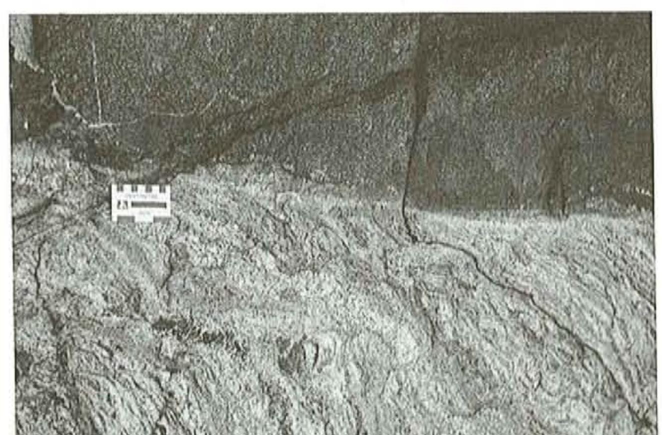

Plate 1. *Sillimanite – garnet – muscovite – biotite metasedimentary gneiss discordantly intruded by metamorphosed mafic dyke; Eagle River area.*

Progressing west, the character of the metasedimentary gneiss changes. Pink-weathering colours are less common, being replaced by grey or rusty shades. Banding, plus leucosome – melanosome contrasts, also becomes less distinct. These features are replaced by heterogeneously textured diatexites showing marked variation in grain size in irregular patches, coupled with more swirly, convoluted and discontinuous gneissosity. The rocks typically contain cordierite, the easternmost occurrences of which are about 10 to 12 km east of the two satellite plutons. In these outcrops, cordierite is easily recognized as blue-mauve glassy crystals locally up to 3 cm across, but more typically less than 1 cm in diameter and found with sillimanite and garnet. Biotite decreases toward the west.

Farther west still, banding in the metasedimentary gneisses is very diffuse and indistinct, being defined by wispy, dark-grey- or black-weathering, generally fine-grained granulitic-textured melanocratic schlieren and lenses within a more-or-less homogeneous monzonitic- to granitic-looking host. Many of these rocks superficially resemble the granitoid rocks of the MMIS to the west (Plate 2), and have a similar magnetic signature (Figure 3). The fine-grained nature of the granulitic melanosome made mineral identification difficult in the field, although quartz, garnet, orthopyroxene, plagioclase and a magnetic opaque mineral could normally be confidently identified. Cordierite was strongly suspected as much of the melanocratic schlieren has a dark blue-grey hue, but the mineral could only rarely be positively recognized in these fine-grained aggregates. Brief examination of thin sections, prepared from samples collected during the field season, has confirmed that it is common (see section on Metamorphism, page 68). Quartz-rich and rusty-weathering layers occur locally and are interpreted to be related to quartzite and sulphide-rich mudstone protoliths, respectively (see section on Economic Potential, page 69).

In a few places within the metasedimentary gneisses, leucocratic, quartz-, plagioclase- and pyroxene-bearing rocks were recorded, for which the preliminary name enderbitic granulite is used (Figure 2). East and southeast of the northern satellite intrusion, they show some indication of layering. The origin of these rocks is uncertain; most likely they are either remnants of metamorphosed, layered leucogabbronorite intrusions or mafic supracrustal rocks.

Plate 2. *Cordierite – garnet metasedimentary gneiss; 1 km east of northern satellite pluton.*

ORTHOGNEISS

The distribution of gneiss near the eastern border of the map region is very speculative as exposure is extremely poor. On the basis of that seen, the area is underlain by creamy-brown- to pink-weathering, medium- to coarse-grained, well-banded granitic to granodioritic gneiss. The layering, defined by quartz-feldspar leucosome and mafic-mineral-rich veneers, is commonly irregular and indistinct. Biotite is the dominant mafic mineral and garnet is present locally in the leucosome.

The southeast orthogneiss area is also very poorly exposed, outcrops being mostly along river sections. Observed rocks are mainly of biotite granodiorite to hornblende – quartz-diorite composition. The gneisses are white-, grey-, creamy-, or brownish-weathering, generally medium grained, and well layered (Plate 3). Layering is regular to irregular and defined by variations in grain size and mineral concentrations. Thick to thin leucosome layers are generally coarsest grained and, in addition to quartz and feldspar, locally contain hornblende, clinopyroxene or orthopyroxene. Garnet is uncommon in either the leucosome or the melanosome. Thin veneers of melanosome comprise feldspar with hornblende and/or biotite grading into broader layers of more homogeneous biotite granodiorite to quartz

Plate 3. *Granodioritic orthogneiss with minor amphibolite. Outside the frame of the photograph, the orthogneiss is discordantly intruded by metamorphosed mafic dykes. Site sampled for U – Pb geochronological study; Eagle River area.*

diorite. The latter probably represents the igneous protolith of the gneiss in part.

Local lenses of diorite to quartz-diorite gneiss were recorded where crossed on stream sections (not separately distinguished on Figure 2). It is not difficult to imagine these might underlie large areas within the orthogneisses. Apart from having a slightly different bulk composition, they are comparable to the granodioritic rocks and are assumed to share a common history; similar comments apply to the K-feldspar augen orthogneiss. The augen are mostly small (2 by 1 cm), typically partially to completely recrystallized and found in rocks that have a separate leucosome component. Small lenses and larger areas designated as hornblende granite and monzonite (Figure 2) are more homogeneous, but it remains unknown whether the homogeneity is due to the rocks having escaped the migmatization event that affected the remaining gneisses, or whether they merely show less effect of it.

The orthogneisses commonly contain veins of both concordant and discordant pegmatite and aplite, which are typically deformed and show boudinage or buckled form. Muscovite is present in a few pegmatites.

MISCELLANEOUS ULTRAMAFIC – MAFIC ROCKS ASSOCIATED WITH GNEISS

In orthogneiss, amphibolite occurs most commonly as black-weathering, medium-grained, recrystallized lenses and boudinaged pods, mostly concordant to gneissosity and typically invaded by quartz-feldspar veins. The mineral assemblage consists of hornblende, plagioclase and an opaque mineral, commonly with some partially altered clinopyroxene. The amphibolite lenses are assumed to represent deformed remnants of metamorphosed mafic dykes, especially as two mafic dykes still preserving discordance to gneissosity were recorded in the map region. One, on the main tributary of the Eagle River is a 10-cm-wide, foliated amphibolite and is itself crosscut by a 3-cm-wide pegmatite; the other, on the Eagle River itself is 30 cm wide and is also foliated. A few larger bodies of mafic rock, up to 200 m wide, occur sporadically in orthogneiss. These are also metamorphosed and injected by felsic veins.

Amphibolite pods and lenses also occur sporadically throughout metasedimentary gneiss. As discordance to an earlier gneissosity is preserved in several places, it is clear that the amphibolite was derived from mafic dykes (Plates 1 and 4). Several well-exposed examples were seen 3 km northeast of the southern satellite pluton. The dykes here are black- to grey-weathering, 10 cm to 2 m wide and consist of plagioclase, hornblende, clinopyroxene and an opaque mineral. Although the dykes postdate the gneiss-forming

Plate 4. *Deformed and metamorphosed mafic dyke intruding enderbitic granulite within a sequence of metasedimentary gneisses; 3 km northeast of southern satellite pluton.*

event, it is evident that both the host rocks and the dykes were affected by subsequent metamorphism as the margins of the intrusions have distinct reaction borders, locally several centimetres wide. Some of the dykes contain large plagioclase phenocrysts, which occur as glomeroporphyritic aggregates in part.

One of the more exotic rocks in the map region is a grey-green-weathering, homogeneous ultramafite a few metres thick containing secondary orthopyroxene veinlets within sillimanite-bearing pelitic gneisses seen on the Eagle River (near the muscovite locality on Figure 2). A thin section confirms the mineral assemblage to be mostly olivine (partially serpentinized), with minor clinopyroxene, and opaque mineral, and phologopite (dunite or olivine-rich wehrlite). Only one outcrop of this rock type was seen and no potentially related rocks occur in the same area, so its tectonic context remains a mystery.

GRANITOID ROCKS

Granitoid rocks near the eastern border of the region are relatively homogeneous, both within individual outcrops and among adjacent outcrops, so coherent plutonic bodies have been depicted in Figure 2, despite sparse exposure. Three main rock types have been distinguished; K-feldspar megacrystic granitoid rocks, hornblende-dominant quartz monzonite to granite, and granite.

The best exposures of K-feldspar megacrystic rocks are on the banks of the Eagle River and two tributaries draining from the northwest. The rocks are creamy-, buff- or pink-weathering, medium- to coarse-grained, moderately foliated, recrystallized biotite-and hornblende-bearing granodiorite, monzonite or granite. The K-feldspar megacrysts are euhedral to rounded, form 15 to 25 percent of the rock and range up to 3 by 2 cm in size. Minor granitoid intrusions are uncommon, but a few mafic enclaves were observed. A sharp contact against orthogneiss was seen on the Eagle River on the southeast side of the body. The area of K-feldspar megacrystic granitoid rock depicted in the northeast corner of the map region is based on a single exposure. The rock has a more gneissic appearance than the megacrystic rocks on the Eagle River. Hornblende quartz monzonite to granite occurs in three separate areas near the eastern margin of the map region, and in all cases is a continuation of the same unit previously mapped farther east (Gower *et al.*, 1986). The body in the southeast is white-, buff-, pink- or brown-weathering, medium- to coarse-grained, moderately to strongly foliated, recrystallized, broadly homogeneous and even textured. It contains enclaves of a fine- to medium-grained granite and is intruded by deformed pegmatite and aplite dykes. These contain the same foliation as their host rock. The dominant mineral is hornblende, but clinopyroxene was tentatively identified in the cores of some grains. Rocks exposed on Eagle River and classified as quartz diorite to quartz monzonite are grouped as part of the same intrusion. The extension of this body farther to the east yielded a concordant monazite age of 1631 ± 1 Ma, which Schärer and Gower (1988) inferred to date the time of rock crystallization. Two discordant zircon fractions from the same rock gave $^{207}Pb/^{206}Pb$ minimum ages of 1735 and 1718 Ma, and were interpreted to reflect inheritance from an unknown source. The rocks in the northeast corner of the study area contain less quartz than those farther to the south, and are better termed monzonite to quartz monzonite. They are pink- to rusty-weathering, medium to coarse grained, recrystallized and foliated to gneissic.

The body of hornblende quartz monzonite in the central-east part of the map region is based on one outcrop. It shows some similarity with K-feldspar megacrystic rocks farther south and may be a border phase of a single pluton. At the exposed locality, some very garnet-rich rocks were observed that are comparable to white-weathering metasedimentary diatexite described from elsewhere in eastern Labrador and could indicate a remnant of metasedimentary gneiss in the area.

GRANITOID ROCKS OF UNCERTAIN AFFINITY

Difficulties in classifying the rocks in the southwest part of the map region are exacerbated by the paucity of exposure and because the few outcrops that do exist show appreciable variety. On the basis of widely separated outcrops, the southwest area is divided into three units (cf. Figure 2).

Monzonite in the southwest corner of the map region weathers creamy-buff, is massive to moderately foliated, homogeneous and has a characteristic sugary texture. The rocks are fine grained, but as the outlines of former larger grains are evident in stained slabs, it is clear that the sugary texture and present grain size are a product of polygonization of a formerly medium- to coarse-grained rock. As the foliation is defined by trains of polygonized grains, it is most probably deformational rather than primary. The mineral assemblage comprises K-feldspar, plagioclase, clinopyroxene, amphibole and an opaque mineral, with uncommon quartz and biotite. Both the opaque mineral and amphibole are associated with polygonized clinopyroxene and it seems likely that they are a product of the recrystallization.

Near its northern border, the monzonite contains enclaves of a fine-grained rock comprising feldspar, orthopyroxene(?) and an opaque mineral. It is also intruded by pink, sugary textured, fine-grained granitic dykes up to about 40 cm wide that are pegmatitic in places. Given the widespread evidence of recrystallization and some fabric development, it seems likely that this monzonite predates the larger mass to the north (see below), which could be the source for the granitic dykes.

The quartz monzonite to monzonite farther east is brown-, grey-, creamy- or pink-weathering, weakly to moderately foliated, homogeneous to locally indistinctly banded and mostly recrystallized. The mineral assemblage comprises quartz (generally less than 10 percent), plagioclase, K-feldspar, biotite, amphibole, clinopyroxene and an opaque mineral. At one locality in the area, a granular-textured dioritic gneiss is present (grouped with mafic rocks in Figure 2), comprising a plagioclase – hornblende – clinopyroxene – minor quartz melanosome and a poorly developed quartz-plagioclase leucosome; K-feldspar is present in some layers. Eade (1962), mapped intermediate to basic gneiss immediately to the south and east of this locality. The outcrop mentioned above fits Eade's description, although he probably based his unit on a locality in NTS map area 13B/15; hence the unit could be more extensive than has been shown in Figure 2. The granite – granodiorite unit is creamy- to rusty-weathering, weakly foliated, partially recrystallized and homogeneous. Features common to the grouped outcrops are that the granitoid rocks are unusually quartz-rich, the quartz grains are large (over 1 cm across), and hornblende and biotite are the mafic minerals. On the other hand, as K-feldspar megacrysts over 2 by 1 cm in size were seen at one locality, the rock has a seriate texture at another and is even-textured at a third, the rocks are not all identical. A narrow aplite dyke intrudes the megacrystic granite.

The combination of partially to completely recrystallized textures and weak to moderate fabrics suggests that the granitoid rocks of uncertain affinity are earlier than the MMIS. On present evidence, it is entirely open whether they represent a early magmatic pulse linked to the MMIS or are completely unrelated.

MEALY MOUNTAINS INTRUSIVE SUITE

That part of the MMIS within the map area represents only a small portion of this huge anorthosite- monzonite-charnockite-granite (AMCG) suite, which extends north to Lake Melville and an uncertain distance to the southwest, but possibly reaching the Labrador – Quebec boundary. It has yet to be completely mapped, but probably underlies an area of about 25 000 km^2. The Cape Caribou River Allochthon, north of Lake Melville, has been interpreted as a thrusted equivalent of the MMIS (Bussy *et al.*, 1995), and it is probable that the Double Mer White Hills and Double Mer Barrens structural outliers (Gower, 1986) contain correlative rocks. At the time, Gower (*op. cit.*) assigned the structural domains to the Lake Melville terrane, but now thinks that they are probably better grouped as part of the Mealy Mountains terrane.

Within the map region, the main mass of the MMIS can be subdivided into two lithological groups, namely (i) leucotroctolite, leuconorite and anorthosite, and (ii) melamonzonite, monzonite and granite. Two satellite intrusions within gneisses east of the main body of the MMIS (but probably genetically related to it) are addressed separately below.

Leucotroctolite, Leuconorite and Anorthosite

Although underlying large regions elsewhere in the Mealy Mountains, leucotroctolite, leuconorite and anorthosite are confined to the northwest part of the present map region. The boundaries of this area are fairly well defined as it forms both a topographic and aeromagnetic low (Figure 3). Rocks in this area are classified into two units; leuconorite or leucotroctolite. Each unit includes some of the other, and both include anorthosite. The leuconorite-dominant part forms a crescent-shaped area around the northeast end of the intrusion. This region is also structurally highest, as primary layering indicates that these anorthosite-related rocks form an elongate dome.

The leuconorite – anorthosite unit is pale- to dark-grey or locally buff-weathering, coarse- to very coarse-grained and typically massive and homogeneous. Primary layers, defined mostly by alternation of layers of leuconorite and anorthosite and, less commonly, leucotroctolite, typically range between 2 to 20 cm in thickness and have diffuse boundaries (Plate 5). A plagioclase lamination, interpreted to be primary, was also observed in places. Plagioclase crystals commonly exceed 10 cm in length and plagioclase over 30 cm long is not unusual. Orthopyroxene grains are typically less than 5 cm across, but are locally larger. The rocks also contain a magnetic opaque mineral, and sporadic olivine (locally mantled by orthopyroxene) and clinopyroxene (locally mantling orthopyroxene). Colour index ranges up to 30. Monzonite dykes, 2 to 5 cm wide, discordantly intrude layered leuconorite – anorthosite.

Plate 5. *Layering in leuconorite – anorthosite (MMIS); northwest part of map region.*

Leucotroctolite in the area is also pale- to dark-grey-weathering, coarse to very coarse grained and mostly massive, but the presence of olivine is fairly easy to detect as it weathers to orange, rust or chocolate-brown. Most outcrops lack layering, or show it only indistinctly (Plate 6). Plagioclase lamination is locally present. Plagioclase crystals commonly exceed 15 cm long and crystals over 60 cm were recorded. Olivine is typically less than 5 cm long, but crystals over 10 cm long were seen. Magnetic opaque grains may be up to 5 cm across. Orthopyroxene, typically less than 2 cm but locally over 25 cm, is also common in places. Olivine may be rimmed by orthopyroxene and(or) a magnetic opaque mineral. Some outcrops show considerable variation in both grain size and texture, particularly due to clusters of olivine crystals, or leucocratic patches that in a few instances also

Plate 6. *Leucotroctolite (MMIS); northwest part of the map region.*

contain quartz. Zircon was searched for in these patches but not seen. Including the associated anorthosite, colour index ranges up to 35.

Melamonzonite, Monzonite and Granite

Melamonzonite is used here to describe rocks that, in a field sense, are transitional between gabbroic – noritic units and typical monzonite. The rocks are more melanocratic than the monzonites but contain K-feldspar. In the present map area, such rocks are almost entirely confined to two areas; in the centre of the northern satellite pluton and as an elliptical body in the central-west part of the map region.

Despite the central-west body having been crossed on only one traverse and one helicopter stop made elsewhere within it, its outline is confidently inferred from its obvious donut-shaped high magnetic signature, more apparent on contoured, line magnetic maps than colour shaded-relief versions. The rocks are buff- to brown- and crumbly-weathering, massive to very weakly foliated, homogeneous and locally indistinctly layered. The mineral assemblage is plagioclase, clinopyroxene, orthopyroxene, a magnetic opaque mineral, K-feldspar, minor hornblende and quartz. The K-feldspar occurs either interstitially or as large crystals up to 3 by 1 cm. The magnetic opaque mineral is locally concentrated into clusters, several centimetres across. Elliptical mafic enclaves up to 15 cm long were seen at one site.

The main mass of monzonitic to granitic rocks in the MMIS in the map area is interpreted here as part of one large pluton zoned from megacrystic monzonite in its (western) core, through non-megacrystic monzonite to quartz monzonite and granite at its border. In the east, the pluton intrudes cordierite – hypersthene-bearing metasedimentary gneiss, but farther south the contact is with monzonitic and granitic rocks, which are interpreted to be older. The western edge of the pluton trends north-northwest and is located about 10 km west of the present map area (cf. Nunn and van Nostrand, *this volume*). The whole pluton is characterized by a magnetic high (Figure 3).

Megacrystic monzonite is buff-, creamy-, pale-grey or brown-weathering, generally coarse grained, massive to weakly foliated and homogeneous (Plate 7). Collectively, the unit is labelled megacrystic, but the rocks grade into seriate-textured or very coarse-grained, inequigranular variants; the division between megacrystic and non-megacrystic is not clear. The typical mineral assemblage consists of alkali-feldspar megacrysts in a matrix consisting of clinopyroxene, probable orthopyroxene, a magnetic opaque mineral, little or no quartz, minor amphibole and rare biotite. The largest megacrysts observed have dimensions up to 5 by 5 cm, but

Plate 7. *Megacrystic monzonite (MMIS) from the west-central part of the map region.*

many outcrops contain megacrysts that are not much smaller. Shapes range from ovoid to subhedral; truly euhedral megacrysts are not common. The megacrysts are set in a coarse- to fine-grained matrix that commonly is reduced to be no more than interstitial between megacrysts. Textural evidence, especially the localization of polygonal albitic plagioclase, suggests that the finer grained matrix is partly the product of recrystallization. Plagioclase forms a separate coarse-grained phase in rocks in the southwest part of the region, locally mantling perthitic feldspar cores showing poor stains in slabs that may be mesoperthite. Amphibole occurs both as an isolated phase and in rims around clinopyroxene. Garnet was seen in one sample in the northwest corner of the map region. The overall homogeneity of these rocks is emphasized by lack of minor intrusions or many enclaves. The enclaves that are present are rarely more than a few centimetres long, typically elliptical, rather melanocratic and consist of fine-grained granulite. Sporadic veins or pods of quartz showing gradational margins with their host monzonite occur here and there. The largest seen is 2 by 0.5 m and is fringed with large pink K-feldspar.

Non-megacrystic monzonite is white-, creamy-, buff- or brown-weathering, generally coarse to very coarse grained, massive to weakly foliated and homogeneous. It is typically inequigranular having alkali-feldspar crystals larger than other phases and grades into a megacrystic equivalent. Some of the monzonites are partially recrystallized. Alkali-feldspar crystals range up to 6 by 3 cm, are anhedral to euhedral and commonly have grey mesoperthite cores. Quartz is generally absent or only present as an accessory phase. Clinopyroxene, orthopyroxene, a magnetic opaque mineral and minor amphibole, together with some plagioclase, make up the remainder of the rock. The opaque mineral locally forms an essential phase, forming crystals up to 1 cm across. Together with mafic silicates, it locally defines a diffuse layering (Plate

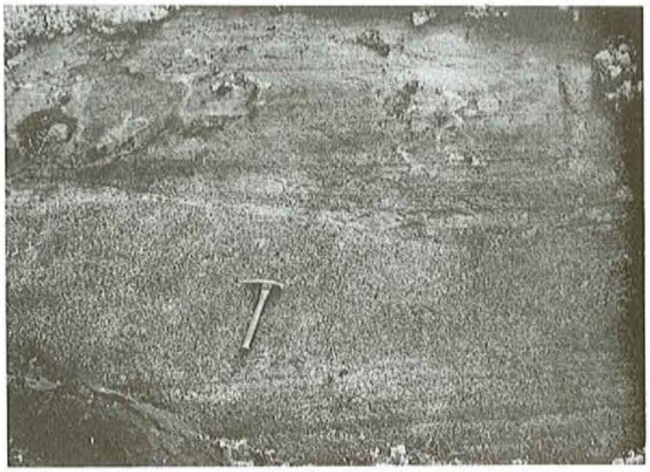

Plate 8. *Layering in monzonite (MMIS) defined by opaque mineral concentrations; west-central part of map region.*

8). Enclaves and minor intrusions are both rare, except for a few small quartz veins.

The quartz monzonite to granite at the border of the pluton weathers creamy, brown, buff, white or pink. It varies from medium to very coarse grained, is massive to weakly foliated (rarely moderately foliated), and homogeneous, except where it contains enclaves or minor granitic intrusions. The coarsest grained and most quartz-rich granite (Plate 9) occurs in the southern part, especially where the granite is in contact with megacrystic monzonite. Particularly in this area, alkali feldspar is sufficiently large compared to the other minerals such that the rock takes on a pseudomegacrystic appearance. Where the foliation is defined by oriented alkali-feldspar grains (with which any enclaves present are normally aligned), it is interpreted as a flow-related emplacement feature. Although grouped as one unit, there is considerable diversity of mineral proportions, especially in quartz concentration, which varies from about 5 to 25 percent. At the lower end of this range, quartz is confined to interstices between large feldspars, but at the upper end forms single grains up to 1.5 by 1 cm. Alkali feldspar typically forms subhedral grains about 2 by 1 cm, but 3 by 2 cm grains are quite common. A K-deficient-feldspar (exsolved albite?) occurs as seams between and within alkali-feldspar grains. Alkali feldspar having blue-grey cores and white sugary rims, seen in outcrop, is interpreted to be mesoperthite having recrystallized margins. In stained slabs, mesoperthite may correlate with cores of less K-rich material within typical alkali feldspar. From field observations, the mafic mineral is considered to be mostly clinopyroxene, but with some orthopyroxene and minor amphibole. A magnetic opaque mineral is also present. Colour index is less than 10. Enclaves (Plate 10) in the border quartz monzonite to granite unit are typically elongate parallel to the border of the pluton, and show considerable variation in both size and density of

Plate 9. *Coarse-grained, massive granite (MMIS) from the southwestern part of the map region.*

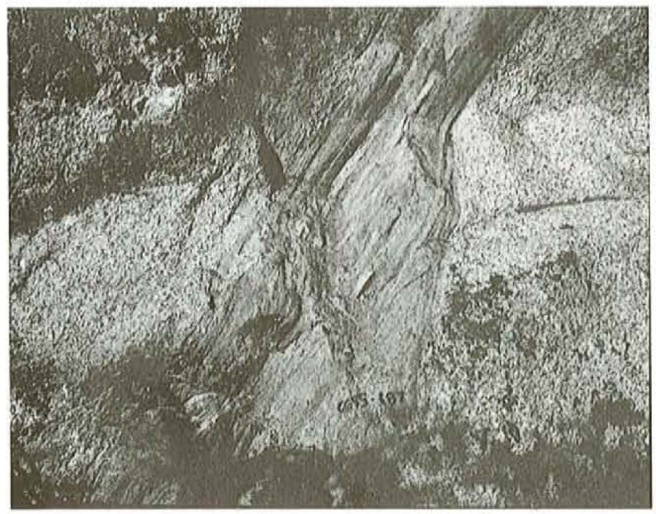

Plate 10. *Enclave of fine-grained gneissic material of uncertain origin in border granite to quartz monzonite (MMIS); southern part of map region.*

occurrence (but rarely more than 20 percent of the rock). The largest seen were about 3 by 0.5 m, but 10 to 20 cm is more typical. They consist of a fine-grained material, in which pyroxene, plagioclase and an opaque mineral can be identified in most hand samples. Judging from differences in colour index, proportions of these minerals (and others not identified) vary significantly. The texture ranges from homogeneous to banded, with the banded varieties having been injected by monzonitic material in a *lit-par-lit* manner. Some pink, fine- to medium-grained granite was also seen. In some places, it has gradational borders with the surrounding coarser grained quartz monzonite to granite; elsewhere it looks to be more clearly intrusive. This material is not abundant and is interpreted here as a late fractionate.

Northern Satellite Intrusion

The northern satellite intrusion is a nearly circular pluton of variable composition. The central part of the pluton coincides with a topographic basin and a magnetic high (Figure 3). It was from a sample of pyroxene monzonite close to the western border of this pluton that Emslie and Hunt (1990, data station EC75-80) reported a zircon $^{207}Pb/^{206}Pb$ concordant age of 1645.5 ± 1.5 Ma, which was interpreted as the crystallization age of the rock.

The border of the intrusion comprises a narrow zone (less than 0.5 km wide) of partially to totally recrystallized leucogabbronorite containing both hornblende and biotite in addition to clinopyroxene, orthopyroxene, plagioclase, an opaque mineral and minor K-feldspar (Figure 2). The border rocks are weakly to moderately foliated and locally have a banded appearance due to grain-size variation and, in the field, superficially resemble monzonitic rocks in the interior of the pluton. Staining has confirmed that the feldspar is almost entirely plagioclase. In one sample, plagioclase occurs as corroded crystals averaging 1 by 0.5 cm in a fine-grained mafic – felsic matrix, hence giving the rock a megacrystic texture. Enclaves of granulite were locally observed in this border phase.

It is hard to capture descriptively the textural and compositional variability demonstrated by stained slabs from the interior part of the pluton. In outcrop, most rocks look to be typical brown-, creamy- or buff-weathering monzonite, that is generally medium to coarse grained, massive to moderately foliated and homogeneous. Whereas monzonite may be the best overall label, the rocks include a texturally wide spectrum of granite, monzonite and syenite. Quartz varies up to 25 percent; perthitic alkali feldspar exceeds plagioclase in most samples and reaches over 95 percent of the rock in some samples. Alkali feldspar locally forms megacrysts up to 2.5 cm long, but these are generally sporadic and little of the pluton could be designated as porphyritic. The feldspar is partly recrystallized to polygonal aggregates separated by necklaces of K-deficient feldspar. Bluish-grey mesoperthite is present in some rocks. Mafic minerals rarely exceed 10 percent of the rock and consist mostly of clinopyroxene with some orthopyroxene, and lesser amphibole. A magnetic opaque mineral is ubiquitous. Coarse-grained norite, tens of metres across (autolithic blocks?) and decimetre-sized mesocratic fine-grained enclaves (suspected to contain cordierite and to be xenoliths), are also present. Small patches of pink, medium-grained, massive granite consisting almost entirely of quartz and K-feldspar most likely indicate minor intrusions, but contacts were not seen so genetic relationships are unknown.

Rocks in the middle of the pluton are somewhat similar to those at the border in texture, but tend to be more melanocratic. The rocks are buff- to grey-weathering, medium to coarse grained, weakly foliated to massive, mela-monzonite to gabbronorite. They are almost devoid of K-feldspar (except for very minor interstitial material) and contain clinopyroxene, orthopyroxene and hornblende, in addition to plagioclase, which is the dominant mineral. A magnetic opaque mineral is locally abundant. The rocks have a relict igneous texture but show signs of recrystallization. On the basis of one outcrop in the outer part of this core zone and having a composition between the monzonorite and the surrounding more felsic rocks, it seems likely that the boundary between the two is transitional.

Southern Satellite Intrusion

Even before the southern satellite pluton was mapped, the distinct cone-shaped hill rising 200 m above the surrounding plain (a well-known landmark for pilots flying between Goose Bay and Paradise River) gave reason to suspect the rocks underlying the area might be different from their surroundings. The pluton is also defined by a magnetic high (Figure 3). Inward dips in the surrounding gneisses suggest that the intrusion is funnel shaped. Outcrops are creamy-, brown- or rusty-weathering, and consist of medium- to coarse- grained, massive to moderately foliated, monzonite to syenite. Because the foliation is local, it is suspected to be related to post-intrusion heterogeneous strain, rather than emplacement. The rocks are dominantly even textured, but some larger euhedral alkali feldspars impart a megacrystic appearance here and there. The feldspar in some samples is almost entirely perthitic K-feldspar, but, in others, plagioclase is equally, or more abundant. Associated minerals include clinopyroxene, amphibole, biotite, a magnetic opaque mineral (above normal concentrations for monzonite in the region), minor quartz (less than 5 percent), and possibly orthopyroxene. At least some of the amphibole appears to be retrograde after pyroxene. Colour index is less than 15. A few small enclaves of fine-grained mesocratic material were seen near the northern border of the pluton.

MEALY DYKES

Mealy dykes are black- to brown-weathering, fine- to coarse-grained east-northeast-trending olivine diabases widespread throughout the Mealy Mountains. Details of their mineralogy, chemistry and age (1380 ± 54 Ma; Rb – Sr whole-rock errorchron) have been presented by Emslie *et al.* (1984), based on samples north of the region addressed here.

Within the present map region, the distribution of the Mealy dykes remains poorly documented. Even where their ground presence has been established, the dykes cannot be extrapolated reliably along strike using aerial photographs. Most of those recorded occur in the northwest part of the map region, but this may be a consequence of it being the most barren, best-exposed district. The dykes tend to occur in closely spaced parallel intrusions, separated by areas where they are sparse or absent. Individual intrusions range from a few centimetres to tens of metres in width with concomitant increase in grain size in centres of the thicker dykes. The average strike and dip of 37 dykes is 258° and 80°N, respectively (the latter figure excluding four steeply south-dipping dykes and one flat-lying intrusion). Most of the intrusions strike within 15° of the average, but the range is between 230° and 295°. The flat-lying intrusion is clearly anomalous, but there is little doubt from textural evidence that it belongs to the Mealy dyke swarm. The dyke is about 2 m thick and was observed in two places about 700 m apart, dipping 11° northwest at one and 30° southeast at the other. Following slabbing and staining, many fine-grained mafic rocks, for which classification was not immediately obvious, could be confidently assigned to the Mealy dyke swarm. Despite the rocks showing a wide range in grain size from gabbro to aphanitic, all (except the grain-size extremes) are characterized by a distinct 'felted' texture governed by randomly arranged, acicular, quenched plagioclase grains that were clearly early crystallized. This point is important in identifying fine-grained mafic rocks in the country rock gneisses east of the MMIS as part of the Mealy dyke swarm, especially as either the dykes have more diverse orientations than their counterparts to the west or the poorer exposure prevents dyke trend being known at all. The more varied strikes are attributed to later deformation, which caused more disruption in the gneisses than the MMIS. This study is the first to identify Mealy dykes outside the MMIS. Note, however, that they are confined to the Mealy Mountains terrane. This may be because the Mealy Mountains region escaped severe Grenvillian effects (e.g. Emslie *et al.*, 1984), and that similar dykes have been metamorphosed beyond recognition in adjacent terranes, but it may also mean that the Mealy Mountains terrane was elsewhere prior to thrusting during Grenvillian orogenesis. Adopting that latter position, and assuming the dykes were emplaced as vertical intrusions, the average 80°N dip implies that the whole of the terrane was transported along thrust surfaces that were very shallowly south-dipping, an inference consistent with structural data farther north.

STRUCTURE

The structural geometry of the map region is the product of several deformational events. One or more early periods of deformation generated the fabrics seen in both the orthogneisses and metasedimentary gneisses. The regional pattern of gneissosity suggests that the orthogneiss forms the core of a north-plunging antiformal dome. Evidence was not found to indicate that either the orthogneiss or the metasedimentary gneiss escaped any deformational event that affected the other. As fabrics in both groups are discordantly truncated by mafic dykes that are themselves metamorphosed, boudinaged and veined by quartzofeldspathic material, it is clear that multiple deformation has occurred. Pegmatite and aplite discordantly intruding host-rock gneissosity and other, more severely deformed minor granitoid intrusions, also attest to multiple deformation.

Geochronological data are lacking for any of the gneisses within the map region, but primary igneous mineral assemblages in the ca. 1380-Ma Mealy dykes and their discordant contacts against gneissosity, coupled with previous studies in adjacent areas, indicate that much of the deformation must be Labradorian or older. As elsewhere in the eastern Grenville Province, the relative roles of Grenvillian versus Labradorian (and Pinwarian?) deformation are difficult to distinguish. It has been established that Grenvillian effects were relatively mild in the MMIS (Emslie *et al.*, 1984; Reynolds, 1989). Support that this conclusion also applies to other parts of the Mealy Mountains terrane was presented by Schärer and Gower (1988).

The granitoid rocks in the east are also strongly deformed in places. Whereas they have not been subjected to the same high-grade events as those which affected the gneisses is indicated by their lack of severe migmatization and supported by a late Labradorian (1631 ± 1 Ma) age from a correlative intrusion a few kilometres east of the southeast corner of the map region.

Some fabrics in the MMIS are undoubtedly related to emplacement, as the crystal alignment conforms with primary layering and unit boundaries, or grains are orientated in unrecrystallized rocks. Nevertheless, in many places, rocks do show evidence of recrystallization coupled with elongation of crystal aggregates and these effects may be quite marked, so it cannot be assumed that all fabrics in the MMIS are primary. A few examples of sheared contacts and faulted offsets of Mealy dykes provide proof of post-Mealy dyke deformation. Pseudotachylite was seen at two localities in the northwest part of the map region – within monzonite at one place and separating monzonite from leucotroctolite at another. There are no constraints on the timing of deformation that produced it.

Mylonitization seen in the southeast part of the region, which appears to be linked with lower grade metamorphism, may be related to Grenvillian thrusting. West-northwest-directed thrusting would be consistent with the regional tectonic picture, it would explain the lobate pattern of granite and gneiss in the east, and would provide an explanation for why the lens of dunite – wehrlite is where it is.

Projection of major structures, coupled with interpretation of regional magnetic data, suggests that the

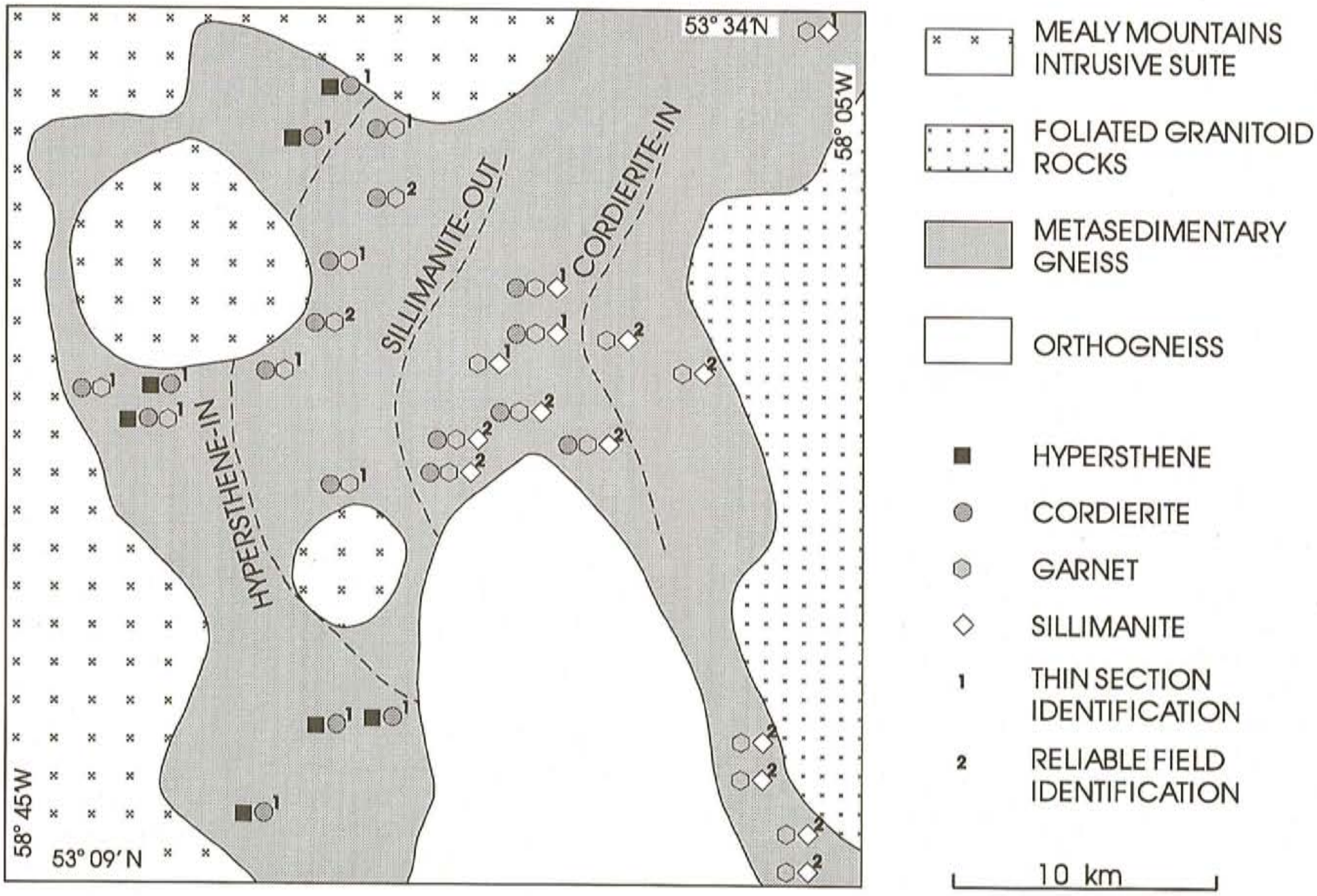

Figure 4. *Preliminary assessment of mineral assemblage distribution in metasedimentary gneiss in the map region; based on thin-section data augmented by selected most reliable field identifications.*

boundary between the Mealy Mountains and Lake Melville terrane might clip the northeast corner of the map region. Some evidence of transposition was observed in this area, but no structural features were judged to have terrane-bounding significance. The area is very poorly exposed, so a fault has been depicted on the map, an interpretation that admittedly favours current regional concepts over local confirmation.

Brecciation, low-grade alteration, and heavily jointed rocks, coupled with an obvious topographic lineament, are the evidence for proposing a major brittle fault in the southeast part of the map region. On the basis of its nature and trend, it is most likely a late-Neoproterozoic structure related to the Lake Melville rift system, Long Range dykes and other phenomenon linked to the opening of Iapetus Ocean.

METAMORPHISM

Mineral assemblages within orthogneisses indicate amphibolite-facies conditions, with retrogression to greenschist-facies assemblages in places.

In metasedimentary gneiss, mineral assemblages show prograde variation from east to west across the map region (Figure 4). It is emphasized that Figure 4 is preliminary, being based mostly on briefly examined, recently obtained thin sections. These observations are augmented by field identification of cordierite, garnet, sillimanite and orthopyroxene and the most reliable information is included in Figure 4. Note that the northern boundary of Figure 4 extends north of the present map region to include thin-section data from a few samples collected from the southern part of NTS map area 13G/northeast (cf. Gower *et al.*, 1983). In the easternmost gneisses, mineral assemblages contain sillimanite and garnet, in addition to quartz, plagioclase, K-feldspar, biotite and an opaque mineral. Farther west, cordierite is stable and co-exists with garnet and sillimanite across a broad zone. Biotite decreases across this band and was consumed, along with sillimanite, to yield garnet and cordierite. Farther west still, hypersthene appears along with hercynite, formed mainly at the expense of biotite.

The east-to-west prograde field gradient is toward the MMIS so the conclusion that there is a genetic linkage between regional metamorphism and the formation of the MMIS seems inescapable. Nevertheless, sufficient spatial control exists to suggest that there is no close link, as the tentatively drawn reaction lines seem to be independent of the MMIS intrusion boundaries. The boundaries also seem to be independent of orthogneiss distribution. Therefore, if the orthogneiss occupies the core of a domal antiform as proposed above, metamorphism must have outlasted deformation.

ECONOMIC POTENTIAL

Three mineral exploration targets were identified during mapping: pyritic gossans, oxide accumulations and pegmatites.

Although the metasedimentary gneisses are commonly rusty weathering in the map region, noteworthy pyritic gossans were mapped at only two locations, both in high-grade metasedimentary gneisses close to the MMIS (Figure 2). At both localities, the gossans are continuous across the outcrop and conformable with layering. Two 2-m-thick gossans were seen at one spot (Plate 11) and several 30-cm-wide gossans recorded from the other. The only sulphide confirmed at both localities was pyrite, but minor interstitial chalcopyrite was tentatively identified at the wider gossan. Secondary Cu minerals were not seen. Pyritic boulders were recorded farther north in the same region, but the source was not located.

Plate 11. *Gossan in metasedimentary gneiss; central map region.*

Lake-sediment geochemical results from the region (Friske *et al.*, 1992) do not offer great encouragement to base-metal explorationists. No appreciable departure from background is evident in the vicinity of the two *in-situ* gossans, but slightly elevated base-metal concentrations were reported from the lake draining the area adjacent to the pyritic boulders.

Oxide concentrations, particularly ilmenite, associated with AMCG suites are well known worldwide. In the present map region, observed accumulations are only a few centimetres thick and very magnetic (i.e., probably titaniferous magnetite). They are most common in non-megacrystic monzonite.

A 1.5-m-wide muscovite-bearing pegmatite intruding metasedimentary gneiss and containing books of muscovite up to 5 cm across and comprising 5 percent of the rock was recorded on the Eagle River. Smaller muscovite-bearing pegmatites are common throughout the area (Plate 12).

Plate 12. *Muscovite-bearing pegmatite; Eagle River area.*

ACKNOWLEDGMENTS

Thanks are due to field assistants Andy Churchill and Gary Bugden for their enthusiastic efforts during the field season. The mapping greatly benefited from information provided by, and discussions with Ron Emslie, who shared camp with us for most of the field season. Logistical support from Goose Bay provided by Wayne Tuttle, Wayne Ryder and Richard White of the Newfoundland Department of Natural Resources was much appreciated, as were helicopter services provided by Canadian Helicopters through their pilots Ron Whiffen and Dale Flemming. Gerry Kilfoil of the Newfoundland Department of Natural Resources is thanked for preparing Figure 3. Gratitude is expressed to Don James and Ron Emslie for reviewing of an earlier version of the report.

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