GEOLOGY OF THE DOUBLE MER WHITE HILLS AND SURROUNDING REGION, GRENVILLE PROVINCE, EASTERN LABRADOR[1]

by

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Abstract

The Double Mer White Hills and surrounding region is located near the northern margin of the Grenville Province in eastern Labrador and includes parts of three major crustal segments, namely the Trans-Labrador batholith, the Groswater Bay terrane and the Lake Melville terrane.

The Trans-Labrador batholith comprises two granitoid units, the Walker Lake quartz monzonite and the Crooked River granite, which are inferred to have been emplaced ca. 1650-1600 Ma. The Groswater Bay terrane comprises muscovite- and kyanite-bearing paragneiss, dioritic, granodioritic and granitic orthogneiss, and foliated to gneissic plutons of muscovite-biotite granite and pyroxene quartz syenite. The Lake Melville terrane is located south of the Groswater Bay terrane and separated from it by thrusts or post-Grenvillian faults. It includes kyanite or sillimanite + K-feldspar paragneiss, granitic orthogneiss and granulite facies gabbroic, monzonitic and granitic rocks. Age relationships of these units are unquantified but evidence from adjacent areas suggests that the paragneiss is Aphebian, and remained as remnants after extensive plutonism which probably ceased ca. 1600 Ma.

The area was subsequently intruded by mafic rocks, probably of several ages, especially the Michael gabbro (ca. 1400 Ma). The Double Mer Formation, which consists of unmetamorphosed arkose and conglomerate, was deposited in a post-Grenvillian half-graben.

Introduction

Systematic 1:100,000 scale geological mapping in Labrador during the past five years by the Newfoundland Department of Mines and Energy has focussed on the northern margin of the Grenville Province. Mapping of the area described in this report during the 1983 field season completes geological coverage along the entire length of the Grenville Front (Tectonic) Zone in Labrador.

The area, located in central-east Labrador (Figure 1), includes six NTS 1:50,000 sheet areas (13J/3, 13J/4, 13J/5, 13J/6, 13K/1, and 13K/8), which cover an area of approximately 5500 km^2. Preliminary results from the first year of the Canada-Newfoundland co-operative minerals program in eastern Labrador were reported by Erdmer (1983) who mapped NTS 1:50,000 sheet areas 13F/16, 13G/13 and 13G/14, immediately south of the present area.

Reconnaissance geological mapping at 1:250,000 scale was carried out by the Geological Survey of Canada; NTS sheet area 13K (east half) was mapped by Williams (1970) and 13J by Stevenson (1970). Present work has refined the distribution of rock units but, because of very low outcrop density, most geological boundaries and structural interpretation remain largely conjectural. In contrast, as samples were collected from nearly every outcrop, and have been slabbed, stained (K-feldspar specific) and compared in detail, lithological descriptions and grouping should be more valid.

Regional Setting

The area is located within the Grenville Province, partly straddling the Grenville Front Zone, as depicted by Gower et al. (1980). The line marking the northern "limit of widespread Grenville deformation" (Gower et al., 1980, page 787) is indicated on Figure 1.

[1] Contribution to Canada-Newfoundland co-operative minerals program 1982-84. Project carried by Geological Survey of Canada and Newfoundland Department of Mines and Energy.

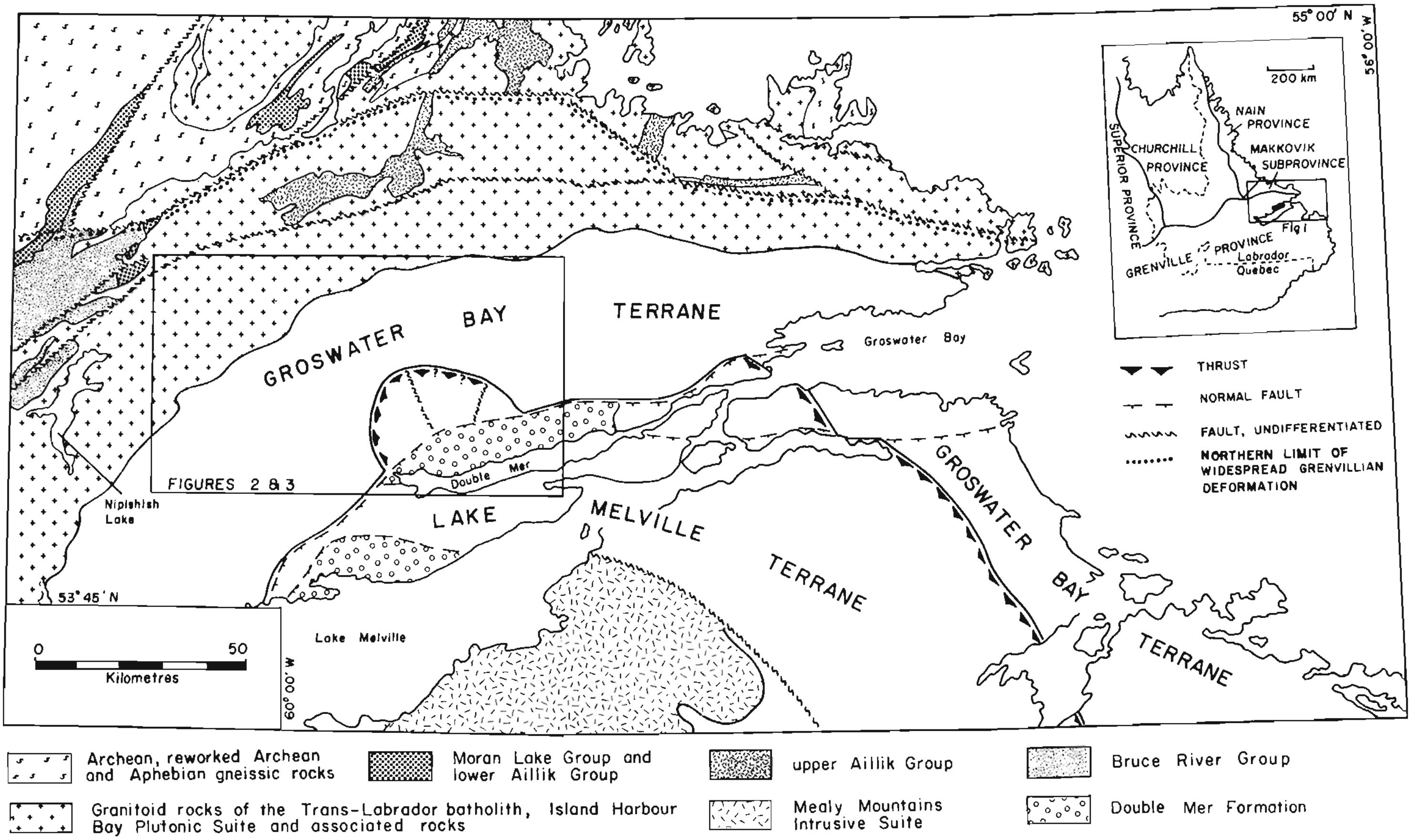
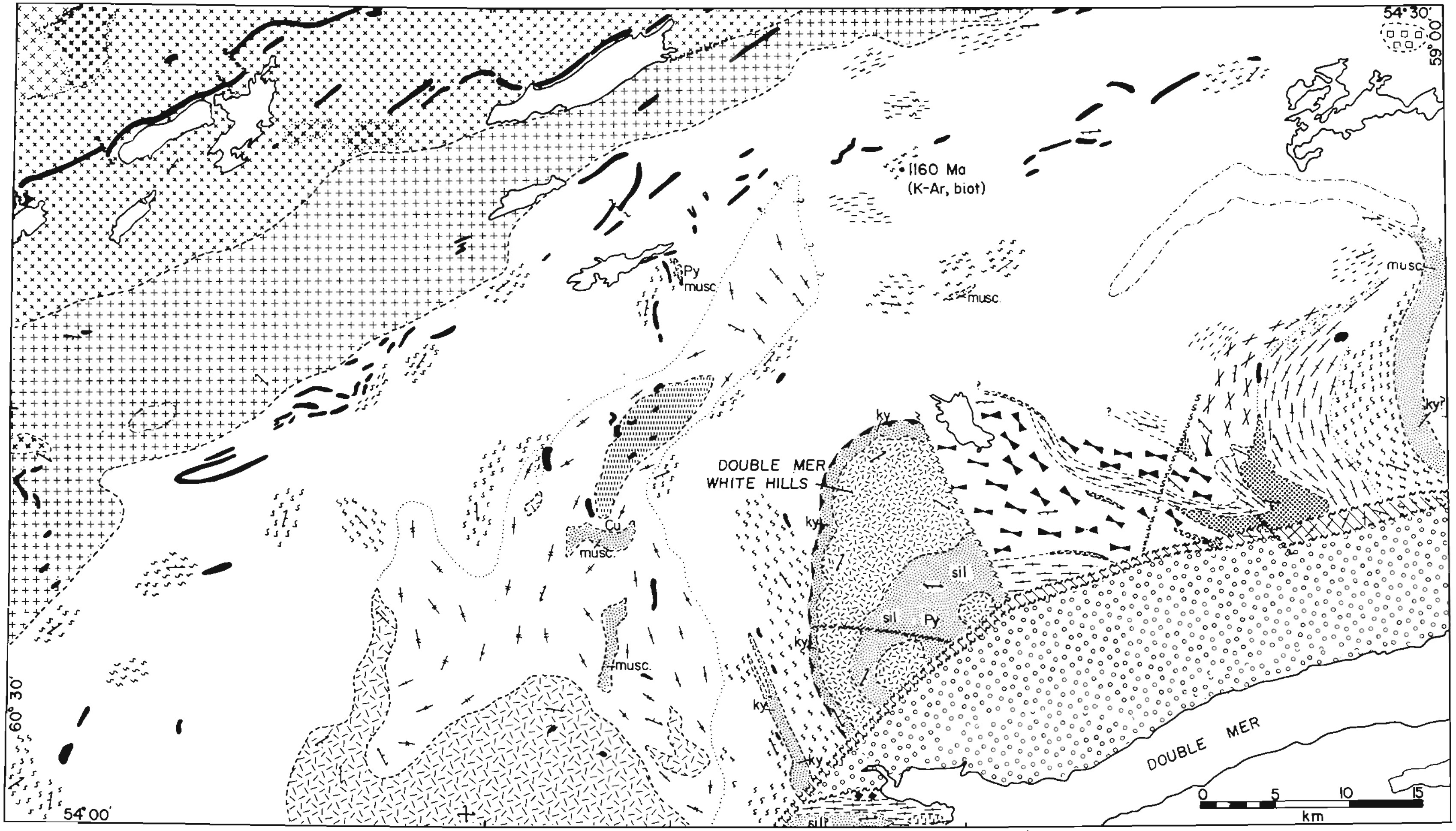


Figure 1: *Regional geological subdivisions of the Grenville Province in eastern Labrador*

The Trans-Labrador batholith (Wardle et al., 1982) is a belt of granitoid rocks along the northern flank of the Grenville Province across much of Labrador. Rock types include granodiorite, granite, quartz syenite and quartz monzonite, and individual plutons have generally yielded 1650-1600 Ma ages. The Trans-Labrador batholith intrudes felsic volcanic rocks of the upper Aillik Group (ca. 1750-1650 Ma) (Bailey, 1979; Gower, 1981). Elsewhere, the Trans-Labrador batholith is in part unconformably overlain by the Bruce River Group but includes plutons intrusive into the Bruce River Group (ca. 1530 Ma) (Ryan, 1981). The granitoid rocks are regarded as genetically related to felsic volcanic rocks in the upper Aillik Group and to similar rocks in the Bruce River Group (Bailey, 1979; Ryan, 1981). This implies plutonism/volcanism extending over a considerable length of time.

The terms Groswater Bay terrane and Lake Melville terrane refer to two constrasting geological regions recently identified by the author in the Grenville Province of eastern Labrador. These regions are structurally bounded crustal segments delineated on the basis of lithological associations, structural style and grade of metamorphism. Characteristics of these two terranes are detailed by Gower and Owen (in preparation) and are briefly summarized here.

Rock types in the Groswater Bay terrane include tonalite/granodiorite orthogneiss, pelitic/psammitic paragneiss, K-feldspar megacrystic granodiorite, diorite, pyroxene-bearing granitoid intrusive rocks and mafic rocks of various ages. Structural trends, where little modified by Grenvillian deformation, are north to northeast, and are similar to the Makkovik trend



HADRYNIAN

Double Mer Formation: red arkose and minor conglomerate

HELIKIAN

Gabbro, leucogabbro, amphibolite: includes Michael Gabbro

TRANS-LABRADOR BATHOLITH

Biot. granite — Otter Lake–Walker Lake Granite
Biot. hbl. qtz. monzonite — Otter Lake–Walker Lake Granite
Hbl. monzodiorite — Otter Lake–Walker Lake Granite

Crooked River Granite: pink, musc. and biot. microgranite

K-fs. megacrystic biot. granite

HELIKIAN (continued)

FOLIATED TO GNEISSIC PLUTONS
GROSWATER BAY TERRANE

Musc.-rich granite

Pyx. qtz. syenite to granite

LAKE MELVILLE TERRANE

Hbl. qtz. monzonite to granite

K-fs. megacrystic biot. granodiorite

Leucomonzonite opx-cpx. granulite

LAKE MELVILLE OR TRANSITIONAL TERRANE

Opx-cpx. monzonite-granite granulite

Pyx.-bearing diorite to gabbro

HELIKIAN AND/OR APHEBIAN?

ORTHOGNEISS: GROSWATER BAY AND LAKE MELVILLE TERRANES

Musc. biot. granite gneiss

Biot. granite gneiss

Biot. granodiorite gneiss

Biot. hbl granodiorite-diorite gneiss

K-fs. augen granodiorite gneiss

Unexposed, assumed underlain by gneiss

APHEBIAN?

Pelitic and psammitic paragneiss, minor calc-silicate rock and quartzite

Fault breccia zone

Fault

Thrust

Geological boundary — approximate, diffuse

Foliation or gneissosity

Marked aeromagnetic anomaly

Cu Malachite
Py Pyrite
musc Muscovite
ky Kyanite
sil Sillimanite

Figure 2: *Geology of the Double Mer White Hills and surrounding region.*

in the Makkovik Subprovince. There is a metamorphic grade variation southward across the Groswater Bay terrane from greenschist to middle amphibolite facies.

Rock types in the Lake Melville terrane are similar to those in the Groswater Bay terrane, but proportions differ. For example, paragneiss is more extensive, and includes minor calc-silicate layers. Mafic rocks, except near the northern flank of the Lake Melville terrane, are less common. In contrast to relatively (deceptively?) simple structural patterns in the Groswater Bay terrane, the Lake Melville terrane shows chaotic structural trends. Also metamorphic grade is generally higher; the broad northern fringe of the Lake Melville terrane is characterized by medium pressure granulite facies rocks which grade southward into middle amphibolite facies assemblages.

The Mealy Mountains Intrusive Suite comprises leucotroctolite, leucogabbro, anorthosite and related rocks, intruded by pyroxene quartz monzonite (Emslie, 1976). It is bounded on its northwest and northeast sides by faults, but a southeast lobe appears to be intrusive.

Description of Rock Units

Trans-Labrador batholith

The Trans-Labrador batholith within the map area (Figure 2) comprises two contrasting granitoid units. In the north is the Walker Lake quartz monzonite, which is part of the broader Otter Lake - Walker Lake granite (Ryan, 1982).In the south is the Crooked River granite, also defined by Ryan (1982).

The Walker Lake quartz monzonite is dominantly a coarse grained, seriate textured, biotite hornblende quartz monzonite, but compositional variations include monzodiorite and granite. Mafic enclaves and minor intrusions are rare. No age dating has been carried out on the Walker Lake quartz monzonite within the map area, and geochronology has not been entirely successful elsewhere. Gower, Flanagan et al. (1982) summarized age data available to the end of 1981, which collectively indicate an age of ca. 1600 Ma. Subsequently Brooks (1983) has reported an age of 1628 ± 34 Ma (U-Pb, zircon) for biotite-hornblende quartz monzonite that previously yielded a 1595 ± 34 Ma (Rb-Sr) errorchron. However some doubt exists whether the quartz monzonite dated by Brooks is the same unit as that underlying the present map area (Ryan, personal communication, 1983).

The Crooked River granite is a homogeneous, fine to medium grained muscovite-biotite granite. Quartz veins, hematized fractures, and a lack of mafic enclaves are characteristic. Typically, the rock has a sugary texture, but where deformed takes on a schistose appearance, making it similar to feldspathic metasediment, a previously suggested protolith (Williams, 1970). Lack of bedding, homogeneity over wide areas, and intrusive contacts with other granitoid rocks confirm the plutonic nature of this unit.

A small area of K-feldspar megacrystic granodiorite occurs in the northeast corner of the map area. The rock is strongly foliated with K-feldspar augen up to 4 cm long. It has been included with the Trans-Labrador batholith but could equally well be grouped with the Groswater Bay terrane.

Groswater Bay Terrane

The Groswater Bay terrane is underlain by paragneiss, orthogneiss and foliated to gneissic plutons.

The paragneisses, by inference from evidence in adjacent areas, are assumed to be Aphebian in age, but may be Helikian. Volumetrically, they are a minor rock type in the Groswater Bay terrane. The most common lithologies are gray weathering, medium grained, quartzofeldspathic pelitic and semipelitic schists and gneisses. The gneissose varieties consist of alternating layers of a muscovite + biotite + opaque + garnet 'melanosome' (it is not melanocratic), and a coarser grained quartz + plagioclase ± K-feldspar leucosome. Locally the schists are ocherous weathering due to associated sulfides, largely pyrite but also minor arsenopyrite and/or chalcopyrite. Near the southern margin of the Groswater Bay terrane the pelitic rocks have kyanite- and K-feldspar-bearing assemblages. These are also muscovite-bearing but, pending petrographic examination, equilibrium relationships are uncertain. Kyanite was not positively identified in hand samples of pelites from the eastern part of the area, but it occurs in pelitic rocks immediately east of the map boundary (Gower, Gillespie et al., 1983). Other metasedimentary rock types within the Groswater Bay terrane include quartzite, calc-silicate rocks and layered amphibolite.

The orthogneisses include, in order of decreasing color index, (i) biotite-hornblende granodiorite-diorite gneiss, (ii) biotite granodiorite gneiss, (iii) K-feldspar augen granodiorite gneiss, (iv) biotite granite gneiss, and (v) muscovite-biotite granite gneiss. These gneissic types grade into each other and into more uniform, foliated granitoid units. The latter feature is a major reason for interpreting derivation from the igneous protolith.

Biotite-hornblende granodiorite-diorite gneiss is the most extensive and includes amphibolite enclaves, diorites and hornblende granodiorite gneiss. Particular compositional and textural varieties tend to be grouped in subareas, suggesting that they outline former plutons. The only age date available from the map area was obtained by Wanless et al (1972) for a rock here included as biotite-hornblende granodiorite-diorite gneiss. The age, 1160 ± 40 Ma (K-Ar, biotite, recalculated using IUGS recommended constants) reflects Grenvillian effects but the gneisses are much older. Krogh (1983) reported a U-Pb age of ca. 1680 Ma for similar gneisses in the southwest continuation of the Groswater Bay terrane.

Biotite granodiorite gneiss occurs in two main areas, north and east-northeast of Double Mer White Hills (Figure 2). North of Double Mer White Hills (adjacent to the Crooked River granite), biotite granodiorite gneiss is intermixed with biotite-hornblende granodiorite-diorite gneiss. Included is very sparsely megacrystic biotite granodiorite gneiss and rare muscovite-bearing granodiorite gneiss. The biotite granodiorite gneiss east-northeast of Double Mer White Hills is fine to medium grained, garnet-bearing, and gray weathering, and locally shows complex isoclinal folds.

K-feldspar augen granodiorite is interpreted to underlie an arcuate area in the eastern part of the region. The rock is homogeneous apart from a few indistinct, concordant quartzofeldspathic veins and amphibolite enclaves. K-feldspar megacrysts have been flattened and recrystallized to ellipsoidal aggregates.

Biotite granite gneiss is present east of the K-feldspar augen granodiorite. It is a medium grained rock containing minor garnet and, like the adjacent K-feldspar augen granodiorite, it is intensely foliated and lineated.

The muscovite-biotite granite gneiss, which underlies a large part of the south-central map area, is a fine to coarse grained, pink weathering rock with biotite schlieren, amphibolite enclaves and pegmatitic segregations. Locally extensive, homogeneous patches of pegmatitic muscovite-biotite-garnet granite are present, which may represent melt which crystallized after the peak of deformation.

The larger of two foliated to gneissic plutons in the Groswater Bay terrane is a pyroxene-bearing quartz syenite to granite recognized during reconnaissance mapping (Eade, 1962; Stevenson, 1970). Its outline has been refined during remapping (see also Erdmer, 1983). Rock types include quartz syenite, granite and alkali feldspar granite, with quartz monzonite and muscovite granite in western and northern border areas respectively. Pyroxene is characteristic, but other mafic minerals include garnet, amphibole and biotite. The rock was originally coarse grained but has been recrystallized to a medium grained texture, especially in gneissic borders of the pluton. Krogh (1983) obtained an age of 1632 ± 7 Ma (U-Pb, zircon) from the pluton, south of the present map area.

The muscovite-bearing granite is a medium to coarse grained, massive to strongly foliated rock which also contains garnet and biotite. The borders were not observed, and the surrounding granite gneiss may be merely a more deformed equivalent.

<u>Lake Melville Terrane</u>

Paragneiss within the Lake Melville terrane occurs as two south dipping sheets underlying the Double Mer White Hills, and in a third area at the western end of Double Mer. The structurally lower paragneiss sheet, around the west and north flanks of Double Mer White Hills, has more variability than other paragneisses within the map area, because of a higher proportion of calc-silicate rock and quartzite to semipelite. The semipelitic schist and gneiss is characteristically well banded, with abundant kyanite, K-feldspar and garnet. The associated calc-silicate rocks are medium grained, with an alternating green and red banded appearance, due mainly to variation in pyroxene and garnet proportions. Quartzite layers are white or gray weathering and medium grained; both orthoquartzite and impure psammitic quartzite are present.

Paragneiss in the upper sheet comprises ocherous weathering psammitic gneiss with subsidiary pelite and calc-silicate rock. The pelitic rocks differ from those in the lower sheet in having sillimanite-rather than kyanite-bearing assemblages. The garnets are pale mauve, as characteristic of high grade paragneiss.

The small area of paragneiss at the west end of Double Mer is characterized by extensive leucosome, biotite schlieren, mauve garnet, variable grain size and marked compositional contrast between individual layers. Some of the rocks are diatexite. Sillimanite was tentatively recognized at one locality and confirmed identifications have been made in contiguous areas to the southeast.

Apart from granitic gneiss, most of the orthogneiss rock types described for the Groswater Bay terrane are not present in the Lake Melville terrane of the map area, but are known in Lake Melville terrane elsewhere (Gower, Gillespie et al., 1983; Gower, Noel et al., 1983). Granitic gneiss in the Double Mer Barrens domain (Figures 2 and 3) is interlayered with monzonite-granite granulite. It is a fine to medium grained rock with a strongly foliated, lineated or mylonitic fabric and contains minor garnet and (?)pyroxene. The rock may be simply a lithological variant of the monzonite-granite granulite rather than analogous to other granitic gneisses in the region. Granitic gneiss at the west end of Double Mer is mostly fine grained, homogeneous microgranite closely associated with paragneiss and diatexite. It is possible that this granitic gneiss was derived from a psammitic protolith. Similar rocks are more widespread south of the map area and a comprehensive description is given by Erdmer (1983).

Five units have been grouped as foliated to gneissic plutons in the Lake Melville terrane. These are, (i) granulite facies, pyroxene-bearing diorite to gabbro,

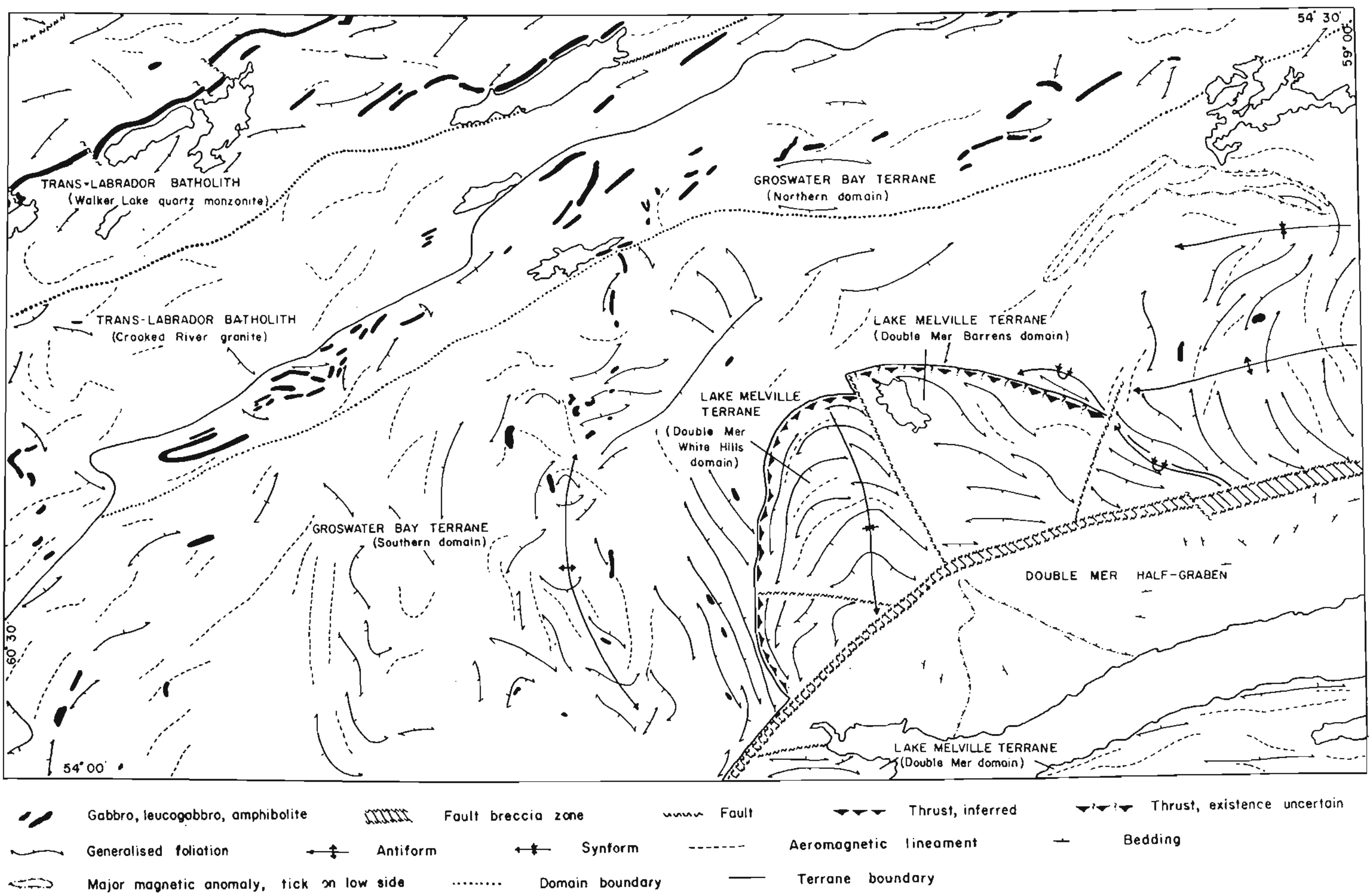


Figure 3: *Lithotectonic terranes, domains and other structural features in the Double Mer White Hills and surrounding region.*

(ii) monzonite-granite granulite, (iii) leucomonzonite granulite, (iv) K-feldspar megacrystic biotite granodiorite, and (v) hornblende quartz monzonite to granite.

The pyroxene-bearing diorite to gabbro unit is interpreted to have been derived from gabbro, leucogabbro, anorthosite and diorite. These rocks are grouped because of their mutual association, low quartz content and lack of K-feldspar. Although it is tempting to regard these rocks as remnants of a former layered mafic intrusion, on present knowledge it is equally possible that entirely genetically disparate rocks have been included.

The monzonite-granite granulite is a medium to coarse grained rock containing orthopyroxene, clinopyroxene and abundant garnet. Most outcrops are quartz-poor/K-feldspar-rich monzonite, but the more northerly and easterly areas are underlain by quartz-rich monzonite and granite respectively. Taken at face value, Figure 2 suggests equivalence between the granulite facies quartz monzonite and K-feldspar augen gneiss within the Groswater Bay terrane. The rocks indeed have textural similarities. Stained slabs suggest compositional contrasts, however, although these may be interpretable in terms of granulite facies dehydration of biotite to give anhydrous mafic phases and additional K-feldspar. This avenue will be explored further when petrographic and chemical data are available.

The leucomonzonite granulite underlying the Double Mer White Hills occurs as two separate, lithologically similar sheets. The rocks have been thoroughly recrystallized to a fine or medium grained rock with a streaky, layered appearance, due to extreme flattening and stretching. The white weathering appearance of the rock gives a misleading impression that K-feldspar is rare, which staining has demonstrated unfounded. The rock differs from the monzonite-granite granulite farther east because of its finer grain size and much lower garnet content.

The remaining two granitoid units occur at the west end of Double Mer. The K-feldspar megacrystic biotite granodiorite contains elliptical megacrysts up to 8 cm long. This unit correlates with a K-feldspar megacrystic granodiorite sheet farther east mapped by Erdmer (1983) on the south side of Double Mer. The hornblende quartz monzonite to granite is a coarse grained, homogeneous monzonite to granite observed at one locality. It is lithologically comparable to much larger bodies on the southeast side of Lake Melville (Gower, Noel et al., 1983).

Mafic Intrusions

Mafic intrusive rocks within the map area are discussed with the following two considerations in mind.

(i) Although it has been recognized that mafic intrusive rocks were emplaced at various times in the Grenville Province of eastern Labrador (Gower et al., 1981; Gower, Owen and Finn, 1982; Owen and Rivers, 1983), it is rarely possible to assign a particular outcrop to a particular intrusive pulse. For this reason, mafic intrusions are not subdivided on the map, and have been collectively grouped as Helikian in age. Nevertheless, two periods of mafic activity at ca. 1650-1600 Ma (*cf.* Adlavik Intrusive Suite) and ca. 1400 Ma (*cf.* Michael gabbro) appear to be of major significance compared to the others (Gower and Owen, in preparation).

(ii) Mafic intrusive rocks, with some exceptions, show a progressive increase in deformation and/or metamorphism southeastward across the map area.

Within the Walker Lake quartz monzonite, mafic rocks fall into two main groups, both of which are assigned as Michael gabbro. These are a northern, continuous sheet and a southern discontinuous sheet. The northern sheet is a coarse grained, massive olivine gabbro without coronite textures or garnet. K-feldspar is a common interstitial phase. The southern gabbro is mineralogically and texturally similar, but it occurs as a series of elongate, discontinuous bodies. Rarely, double coronas are present (an inner corona of hypersthene and an outer corona of pargasitic amphibole; see Emslie, 1983), and a few rocks contain scattered garnet.

Gabbroid rocks are less abundant in the Crooked River granite. The three mafic bodies closest to the northern border of the Crooked River granite are biotite-bearing amphibolite, locally with relict ophitic textures. In view of the fact that most of the surrounding rocks are only slightly metamorphosed gabbros, these rocks may be the product of an earlier metamorphic event, perhaps related to neither the 1650-1600 Ma suite nor the 1400 Ma gabbros. A cluster of three mafic bodies in the south-central part of the Crooked River granite has very coarse 'appinitic' textures, a feature characteristic of the 1650-1600 Ma suite.

The mafic intrusions at the southwest end of the Crooked River granite are a mixed group of ophitic textured metagabbros, locally with double coronas, grading into amphibolite, especially at intrusion margins. Garnet is present but not in coronas. This group is assigned to the Michael gabbro.

Most of the rocks in the northern domain of the Groswater Bay terrane are fine to coarse grained gabbro to leucogabbro, generally massive, with ophitic textures, and best assigned to Michael gabbro. The gabbros are olivine-bearing with well developed double coronas. Locally partial garnet coronas are present, but more typically the garnets are scattered throughout the rock or concentrated near fractures.

Mafic intrusions are much less common in the southern part of the Groswater Bay terrane. The most northerly gabbros contain double coronas and garnet; these grade southward into garnet-coronite gabbros which still retain relict ophitic textures. Some amphibolite and metamorphosed ultramafic rocks are present and, as farther north, they contrast with nearby coronite metagabbros, suggesting that they are genetically distinct. In the most southerly outcrops in the area, ophitic texture is lost, hornblende (which increases in abundance southward, together with garnet) becomes widespread, and the rocks grade into garnet amphibolite. Hence any textural distinction between the later gabbros and the supposed earlier intrusions is eliminated.

Apart from a few minor mafic intrusions, and the diorite-gabbro unit referred to above, no mafic rocks were mapped within the Lake Melville terrane in the map area. However, it should be noted that mafic intrusions do occur in the Lake Melville terrane farther east and south.

Double Mer Formation

The Double Mer Formation consists of orange, red, pink or maroon weathering, crossbedded arkose sandstone interbedded with shale and conglomerate. These rocks were first named by Kindle (1924) and subsequently mapped by Stevenson (1970). Except for a slight modification at the west end of Double Mer, the present distribution of outcrop shown differs little from that of Stevenson (1970).

Structure

The area underlain by the Trans-Labrador batholith appears to be structurally simple. The granitoid rocks are massive or show weak east-northeast trending foliation which generally dips within 5° of vertical. All shallower dips are inclined southeast. Foliation directions in the Crooked River granite are less consistent than in the Walker Lake quartz monzonite. The arcuate outline of the gabbro near the western margin of the map area implies folding which must have also affected the host granite. In both granitoid units, but especially the Walker Lake quartz monzonite, foliation is inhomogeneous with large areas of massive quartz monzonite between local foliated zones which may be accompanied by low grade alteration. This feature is attributed to regional inhomogeneous Grenvillian strain.

Faulting in two directions is inferred. East-northeast shear zones, accompanied by retrograde alteration, were identified in two places, and northwest trending faults have been interpreted to explain offsets along the northern gabbro.

An important question, especially relevant to the northern domain of the Groswater Bay terrane, is whether the isolated hills of gabbro are part of a subsurface continuous gabbro sheet, with presently unexposed areas having been eroded and covered as a result of glaciation, or else the present outcrop genuinely reflects bedrock gabbro distribution. The former interpretation was adopted by Fahrig and Larochelle (1972), and Emslie (1983), who both depicted the gabbro as anastomosing sheets. In consideration of the opposing viewpoint, the following features are noteworthy: (i) there is a decrease in topographic continuity of exposed gabbro progressively southward, (ii) there is evidence of complex folding (one fold closure has a north trending fold axis), and (iii) many gabbro bodies exposed on the shore of Groswater Bay (outside the map area) exhibit severely deformed and boudinaged margins. Therefore the distribution of gabbro on the sketch map may well reflect bedrock distribution, entertaining the hypothesis that the bodies are 'megaboudins' formed during Grenvillian deformation.

Foliation attitude in the host gneiss is variable, perhaps because many gneiss outcrops are adjacent to gabbro and therefore are influenced by the shape of the adjacent 'megaboudin.' Gneiss remote from gabbro has an east-northeast trend. The poor exposure obscures what is probably a zone of extreme complexity. It is possible that the boundary between the Groswater Bay terrane and the Trans-Labrador batholith is a thrust, a thought endorsed by Ryan (personal communication, 1983) for the comparable boundary farther southwest.

In the southern domain of the Groswater Bay terrane, foliation attitudes and distribution of rock units suggest complex structures resulting from fold interference. The interpretation advanced here is that the pre-Grenvillian structural trend was north to northeast and was subsequently overprinted by east-northeast trending Grenvillian folds.

The nature of the interface between the northern and southern domains of the Groswater Bay terrane is unknown. In the center of the map area, mafic bodies (and structures in associated gneiss) of the southern domain have a north trend. This appears to be truncated by east-northeast trends in the northern domain, which may mean that the two domains are separated by a 'structural discontinuity,' possibly a thrust.

Evidence is strong for a thrust separating the Groswater bay terrane and the Double Mer White Hills domain of the Lake Melville terrane. In addition to a sharp topographic break, structural trends in the Groswater Bay terrane are truncated by those in the Lake Melville terrane, and the Lake Melville terrane rocks exhibit intense stretching lineations, absent in contiguous Groswater Bay terrane gneisses.

Farther east, the boundary between the Groswater Bay terrane and the Double Mer Barrens domain cannot be delineated using ground features (in contrast to the remainder of the Groswater Bay terrane - Lake Melville terrane interface in Figure 1). However, as the boundary elsewhere includes metamorphic as well as structural contrasts, it is hoped that this problem can be clarified after petrographic studies. In Figure 3, the boundary is partly indicated as a thrust and partly located along the axial trace of an interpreted recumbent synform.

The Lake Melville terrane south of Double Mer is characterized by well defined, east trending foliations, variable dip directions and small scale isoclinal folds.

The area underlain by the Double Mer Formation is interpreted as a half-graben, bounded on the north by a major fault. The fault is indicated by brecciated, sheared and mylonitized rocks, low grade alteration, a marked topographic scarp and contrasting aeromagnetic patterns. The 'fan' of three faults on the north side probably is a related structure, perhaps formed in response to the change in trend of the Double Mer fault. The presence of both mylonite and low grade alteration/brecciation suggests that the Double Mer Fault was the site of a pre-existing thrust, which was reactivated as a normal fault when the Double Mer half-graben was formed.

The southern contact between the Double Mer Formation and the underlying gneiss is unexposed. If it is a fault, it is certainly not of comparable magnitude to the fault along the northern contact. Aeromagnetic patterns suggest a north sloping base for the Double Mer Formation. An aeromagnetic high near the west end of Double Mer (Figure 3) is interpreted as a basement culmination. Bedding directions in the Double Mer Formation dip away from this high; whether this reflects folding or a pre- Double Mer Formation erosional irregularity is unknown.

Metamorphism

The Trans-Labrador batholith is characterized by greenschist facies assemblages. Epidote alteration of plagioclase and chloritization of biotite are widespread. No garnet was observed in either the Walker Lake quartz monzonite or the Crooked River granite, but Ryan (personal communication, 1983) has noted small garnets in thin sections of Crooked River granite further west. In the granitoid rocks in the Groswater Bay terrane, garnet is more abundant in the south than the north. Some of the dioritic gneisses bear scapolite. Epidote is widespread. The monzonite to granitoid rocks in the Lake Melville terrane north of the Double Mer fault contain common garnet and ortho- and clinopyroxene. In contrast, granulite facies assemblages were noted south of Double Mer.

The metasedimentary gneiss shows a concomitant increase in metamorphic grade in a southeastward direction. Muscovite-bearing assemblages are displaced by kyanite + K-feldspar and then sillimanite + K-feldspar assemblages.

Metamorphic variations in mafic rocks can be summarized as follows. In the northwest, the mafic rocks have entirely igneous mineral assemblages. The first change is the sporadic occurrence of garnet, the distribution of which can be related to avenues of fluid access (i.e. shear zones, fractures and pegmatites). Farther south metagabbro exhibits orthopyroxene - pargasitic amphibole double coronas, and garnet is more common. The garnet at this stage is not necessarily in coronas. There is a progressive change southward to mafic rocks with garnet coronas and common hornblende. The metagabbros retain ophitic textures, except at the southern margin of the map area where some rocks are amphibolite.

Economic Mineral Potential

A thorough assessment of the economic mineral potential of the area has never been undertaken, due in part to inaccessibility and to very poor outcrop. The area was included in reconnaissance mineral exploration by British Newfoundland Corporation Ltd. (BRINCO) (Beavan, 1954, 1955; Morrison, 1957) but results proved unrewarding. However, these surveys entailed very rapid coverage of extremely large areas prior to the availability of geological mapping, geophysical or geochemical data; therefore assessments made, in my opinion, can no longer be regarded as reliable.

More recently, extensive uranium and molybdenum mineralization has been found (BRINEX Ltd.) in the upper Aillik Group, in particular the Michelin uranium deposit, located only 8 km north of the present map boundary. Furthermore, uranium mineralization has been discovered (Kerswill and McConnell, 1982) and prospected by Northgate Exploration Ltd. in the Double Mer area, 9 km south of the map area. Thus an additional objective of this study was to determine the relationship between these two areas by examining the intervening ground.

The mineral potential of the area has been further assessed during this project using three approaches, namely (i) background radioactivity, (ii) lake sediment geochemical anomalies, and (iii) mineral occurrences. A scintillometer survey carried out showed that total counts on bedrock decrease from northwest to southeast. The highest values coincide with the Trans-Labrador batholith. This pattern cannot be totally explained by potassium abundance; otherwise higher values would be expected over the monzonites of the Lake Melville terrane.

Lake sediment geochemical anomalies (Geological Survey of Canada / Newfoundland Department of Mines and Energy, 1978) can be divided into two groups. Ni, Co and Fe (locally with Cu and Zn) anomalies are adjacent to mafic intrusions and are unlikely to be of real economic interest. Perhaps more important are U and Mo anomalies (locally also with Cu and Zn), which correlate with areas known, or inferred, to be underlain by paragneiss, or associated muscovite-bearing plutonic rocks.

Three mineral occurrences were located during mapping. The northern pyrite occurrence (Figure 2) and the malachite locality are quite minor, but it is interesting to note that lake sediment Cu anomalies were detected near both. Nevertheless, the lake sediment geochemistry cannot be relied on to detect all mineral occurrences. For example, the southern pyrite locality is by far the largest, having several pyritic layers up to 50 cm thick and locally containing up to 15% (guestimate) sulfide, but no lake sediment anomaly has been reported. In this case, no suitable lakes exist down-drainage for sampling.

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References

Bailey, D.G.
1979: Geology of the Walker-Maclean Lake area, 13K/9E, 13J/12 Central Mineral Belt, Labrador. Mineral Development Division, Department of Mines and Energy, Newfoundland and Labrador, Report 78-3, 17 pages.

Beavan, A.P.
1954: Report on exploration in Labrador and Newfoundland, 1953. British Newfoundland Corporation Ltd. Unpublished report, 76 pages.

1955: Report on exploration in Labrador and Newfoundland, 1954. British Newfoundland Corporation Ltd. Unpublished report with appendices, 35 pages.

Brooks, C.
1982: Unpublished report to Department of Mines and Energy, Newfoundland and Labrador.

Eade, K.E.
1962: Geology, Battle Harbour. Cartwright. Geological Survey of Canada, Map 22-1962.

Emslie, R.F.
1976: Mealy Mountains Complex, Grenville Province, Southern Labrador. *In* Report of Activities, Part A, Geological Survey of Canada, Paper 76-1A, pages 165-170.

1983: The coronitic Michael gabbros, Labrador: assessment of Grenvillian metamorphism in northeastern Grenville Province. *In* Current Research, Part A, Geological Survey of Canada, Paper 83-1A, pages 139-145.

Erdmer, P.
1983: Preliminary report on the geology north of Upper Lake Melville, Labrador. *In* Current Research, Part A, Geological Survey of Canada, Paper 83-1A, pages 291-296.

Fahrig, W.R., and Larochelle, A.
1972: Paleomagnetism of the Michael Gabbro and possible evidence of the rotation of Makkovik Subprovince. Canadian Journal of Earth Sciences, Volume 9, pages 1287-1296.

Geological Survey of Canada / Newfoundland Department of Mines and Energy
1978: Regional lake sediment and water geochemistry reconnaissance data, Labrador 1977. Geological Survey of Canada, Open File 513.

Gower, C.F.
1981: The geology of the Benedict Mountains, Labrador (13J northeast and 13I northwest). Mineral Development Division, Department of Mines and Energy, Newfoundland and Labrador, Report 81-3, 26 pages.

Gower, C.F., Flanagan, M.J., Kerr, A., and Bailey, D.G.
1982: Geology of the Kaipokok Bay - Big River area, Central Mineral Belt, Labrador. Mineral Development Division, Department of Mines and Energy, Newfoundland and Labrador, Report 82-7, 77 pages.

Gower, C.F., Gillespie, R.T., Noel, N., Bailey, D.G., and Doherty, R.A.
1983: Rigolet 1:100,000 map-sheet. Mineral Development Division, Department of Mines and Energy, Newfoundland and Labrador, Map 83-42.

Gower, C.F., Noel, N., and Gillespie, R.T.
1981: The geology of the Rigolet Region, Labrador. *In* Current Research for 1980. Mineral Development Division, Newfoundland Department of Mines and Energy, Report 81-1, pages 121-129.

Gower, C.F., Noel, N., Gillespie, R.T., Finn, G. and Emslie, R.F.
1983: English River 1:100,000 map-sheet. Mineral Development Division, Department of Mines and Energy, Newfoundland and Labrador, Map 83-46.

Gower, C.F. and Owen, V.
in preparation: Pre-Grenvillian and Grenvillian lithotectonic regions in eastern Labrador - correlations with the Sveconorwegian Orogenic Belt in Sweden.

Gower, C.F., Owen, V. and Finn, G.
1982: The geology of the Cartwright Region, Labrador. *In* Current Research for 1981. Mineral Development Division, Newfoundland Department of Mines and Energy, Report 82-1, pages 122-130.

Gower, C.F., Ryan, A.B., Bailey, D.G. and Thomas, A.
1980: The position of the Grenville Front in eastern and central Labrador. Canadian Journal of Earth Sciences, Volume 17, pages 784-788.

Kerswill, J.A., and McConnell, J.W.
1982: Geochemistry and geology of some uraniferous granites in Labrador. *In* Uranium in Granites. *Edited by* Y.T. Maurice. Geological Survey of Canada, Paper 81-23, pages 171-172.

Kindle, E.M.
1924: Geography and geology of the Lake Melville district, Labrador Peninsula. Geological Survey of Canada, Memoir 141, 71 pages.

Krogh, T.E.
1983: Unpublished report to Mineral Development Division, Department of Mines and Energy, Newfoundland and Labrador.

Morrison, E.R.
1957: Preliminary report on the geological mapping of the Asbestos Corporation Joint Venture - Kaipokok Concession. Asbestos Corporation - Brinex unpublished report, 19 pages.

Owen, V., and Rivers, T.
1983: Geology of the Smokey archipelago, Grenville front zone, Labrador. *In* Current Research, Part A, Geological Survey of Canada, Paper 83-1A, pages 153-161.

Ryan, B.
1981: Volcanism, sedimentation, plutonism and Grenvillian deformation in the Helikian basins of Central Labrador. *In* Proterozoic Basins of Canada. *Edited by* F.H.A. Campbell. Geological Survey of Canada, Paper 81-10, pages 361-378.

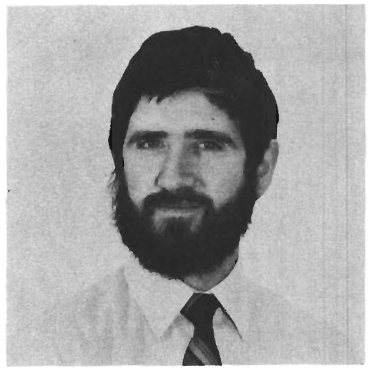
1982: Geology of the Central Mineral Belt, Labrador. Department of Mines and Energy, Newfoundland and Labrador, Maps 82-3, 82-4.

Stevenson, I.M.
1970: Rigolet and Growater Bay map-area, Newfoundland (Labrador) (13J, 13I). Geological Survey of Canada, Paper 69-48, 24 pages.

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Delabio, R.N.
1972: Age determinations and geological studies: K-Ar Isotopic ages. Report 10. Geological Survey of Canada, Paper 71-2, 96 pages.

Wardle, R.J. and staff, Labrador Section
1982: The Trans-Labrador Batholith; a major pre-Grenvillian feature of the eastern Grenville Province. *In* Grenville Workshop, 1982, program with abstracts, page 11.

Williams, F.M.G.
1970: Snegamook Lake (east half) Newfoundland. Geological Survey of Canada, Open File 42.



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