Current Research (86-1) Newfoundland Department of Mines and Energy, Mineral Development Division, Report 86-1, pages 113-123

GEOLOGY OF THE GOOSE BAY - GOOSE RIVER AREA

R.J. Wardle and C. Ash[1]
Labrador Mapping Section

ABSTRACT

The map area lies within the interior Grenville Province and contains the southern part of the Cape Caribou River allochthon and its surrounding rocks. Potentially, the oldest rocks in the area are tonalitic-granodioritic gneiss of plutonic derivation, infolded with sillimanite metasedimentary gneisses and intruded by megacrystic granitoid. The gneisses are overthrust by the Cape Caribou River allochthon, a layered structural slice consisting of a lower unit of granitoid gneiss, and an upper sequence of metagabbroid rocks and anorthosite (North West River anorthositic intrusive suite). These are intruded by a variety of monzonitic, syenitic and granitic rocks (Dome Mountain intrusive suite) which pass westward into extensive foliated granites, syenites and derived gneisses, referred to as the Lower Brook metamorphic suite. The metamorphic suite has been thrust northward over the tonalite-granodiorite gneisses and megacrystic granite.

Absolute ages in the area are uncertain. The tonalite-granodiorite gneisses are thought to be of circa 1650 Ma age, but this may be an oversimplification. There is limited evidence suggesting that intrusion of the North West River, Dome Mountain and Lower Brook suites postdated early fabric development in the gneisses, but were deformed and metamorphosed in a later event.

The drift covered, southeastern part of the map area is inferred to underlie the western termination of the late Precambrian-early Paleozoic Lake Melville graben.

INTRODUCTION

This is the initial report for a new project started in 1985 on the geology of the interior Grenville Province in the Goose Bay region (Figure 1). As such, the project represents a southerly continuation of previous Department of Mines and Energy mapping projects by Ryan *et al.* (1982) and Wardle and Ash (1984).

The map area (Figures 2, 3) is centred on the towns of Goose Bay and Happy Valley, located at the western end of Goose Bay, which opens into Lake Melville (Figure 2). The towns, which benefit from regular coastal boat and commercial airline service, provide centres of road access to much of the map area. More remote parts are best reached by the chartered helicopter or float plane service available in Goose Bay.

The area is divided into a lowland plain, which surrounds Goose Bay and extends along the lower reaches of the Goose, Churchill and Peters rivers, and an undulating upland plateau deeply dissected by the same rivers. The lowland plain is thickly wooded and blanketed by glacial outwash sands and esturine clays (Kindle, 1924). The plateau is more thinly wooded and, with the exception of areas underlain by anorthosite, poorly exposed through a thick mantle of till and glaciofluvial material.

Geological aspects of the map area, notably the surficial deposits and the outcrops around Muskrat Falls (Figure 3), received early mention by Low (1897) and Kindle (1924). The area was examined in reconnaissance fashion by Scott and

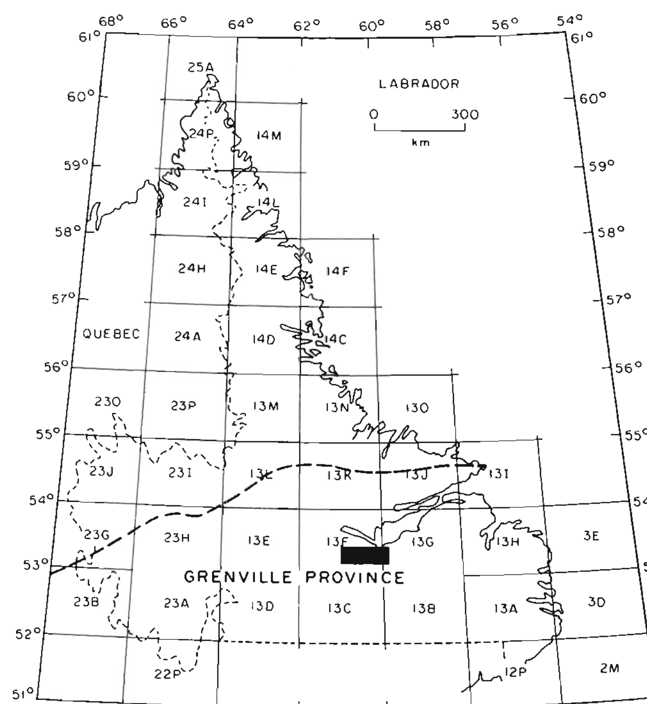


Figure 1: *Location of map area within Grenville Province of Labrador.*

[1] Department of Earth Sciences, Memorial University of Newfoundland.

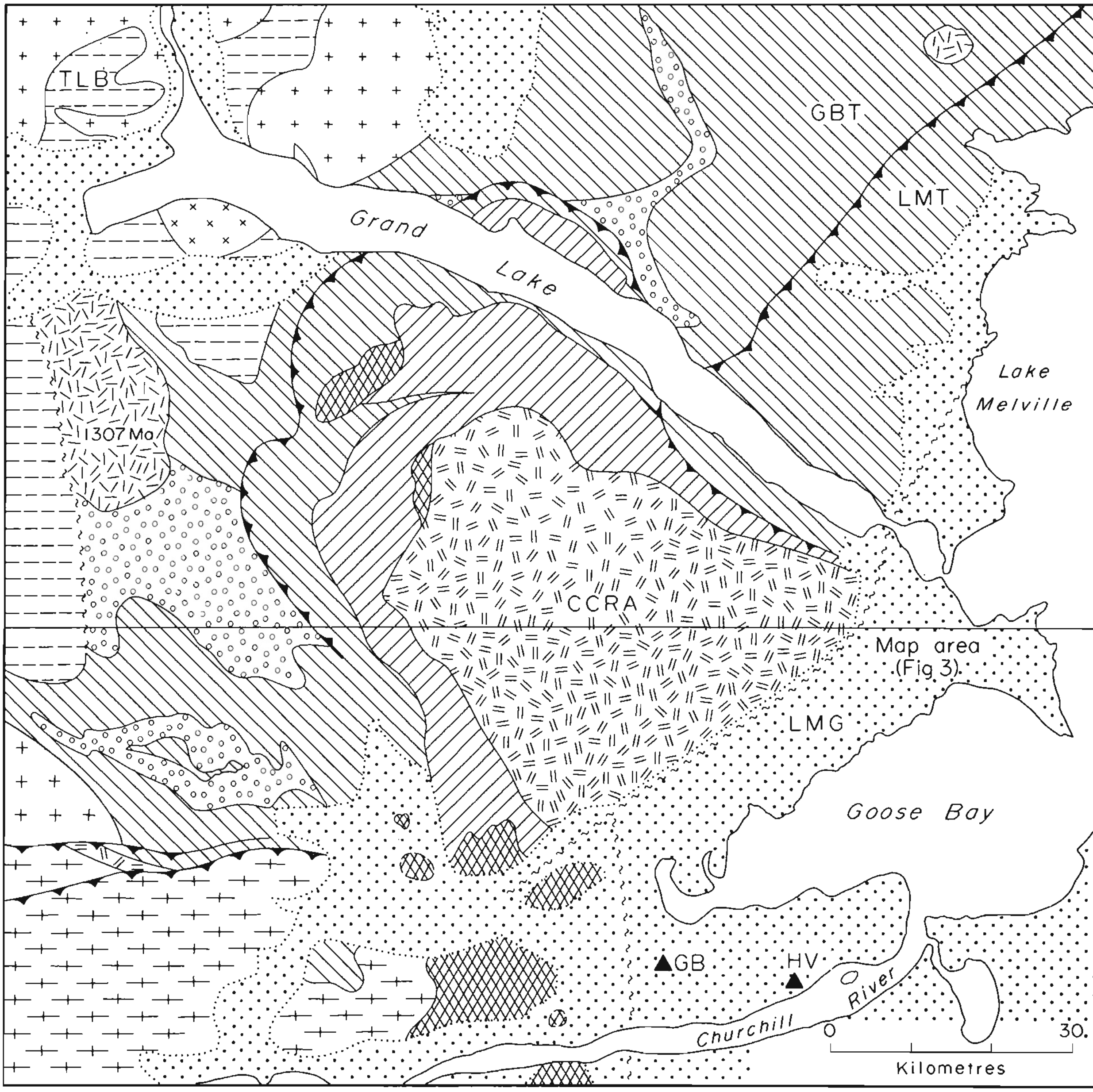


Figure 2: *Regional geology of the Goose Bay area. Simplified after Ryan et al. (1982), Wardle and Ash (1984), and Erdmer (1984). LMT - Lake Melville terrane; GBT - Groswater Bay terrane; CCRA - Cape Caribou River allochthon; TLB - Trans-Labrador batholith; GB - Goose Bay; HV - Happy Valley.*

Conn (1949) as part of a photogeological interpretation of the Goose Bay region, followed by Fulton and Hodgson (1969) who included the map area in their description of the surficial geology of the region. The bedrock geology of the area was not systematically mapped until it was included in the regional, 1″=4 miles, reconnaissance mapping program of Stevenson (1967).

GENERAL GEOLOGY

The geology of the Goose Bay region, as simplified from Ryan *et al.* (1982) and Wardle and Ash (1984 and this report) is summarized in Figure 2. The major feature of the region is the Cape Caribou River allochthon (CCRA), a layered, lobate, structural slice consisting of a lower unit of mylonitic tonalite-granodiorite gneiss (locally orthopyroxene bearing), and an upper sequence of metagabbroid-amphibolite and anorthosite referred to in this report as the North West River anorthositic intrusive suite. The allochthon is underlain by tonalitic-granodioritic gneisses that are generally banded and migmatitic, and infolded with belts of kyanite- and sillimanite-bearing metasedimentary gneiss.

The granitoid gneisses in the northeastern part of the region are divided by a major northeast-trending thrust. Gneisses lying northwest and southeast of the thrust are correlated respectively (Wardle and Ash, 1984) with the Groswater Bay and Lake Melville terranes of Gower (1984),

LEGEND

Pleistocene drift.

PROTEROZOIC

Late monzonite-syenite gabbro intrusions.

Granite-quartz monzonite plutons.

Megacrystic granite.

Metadiorite.

Lower Brook metamorphic suite: granite and granitic gneiss.

Monzonite-syenite-granite intrusions (including Dome Mountain intrusive suite).

NORTH WEST RIVER ANORTHOSITIC INTRUSIVE SUITE

Anorthosite.

Metagabbroid rocks locally layered.

Foliated to gneissic quartz diorite (Susan River quartz diorite).

Metasedimentary gneiss.

Banded, migmatitic, quartz diorite-tonalite-granodiorite gneisses.

Gower and Owen (1984) and Erdmer (1984). Gneiss in the Groswater Bay terrane has been dated at 1680 Ma (Krogh *in* Erdmer, 1984) although it is uncertain as to whether this represents the age of metamorphism or protolith intrusion. Use of the terms Groswater Bay and Lake Melville terranes has, to date, not been extended southeast of the Cape Caribou River allochthon. However, Ryan *et al.* (1982) have described extensive areas of foliated to gneissic quartz diorite (their Susan River quartz diorite) and associated banded, migmatitic, granitoid gneisses, which in general appearance are remarkably similar to rocks of the Groswater Bay terrane.

The Susan River quartz diorite and associated granitoid gneisses are intruded by a variety of deformed granitoid plutons which, in the northwestern corner of the area shown in Figure 2, form part of the Trans-Labrador batholith of 1650-1500 Ma age (Gower and Owen, 1984). Some younger, less deformed, stocks of gabbro, monzonite and syenite also intrude the gneisses and have been dated at one locality at 1307 28 Ma (Fryer *in* Ryan *et al.*, 1982).

The southwestern part of the region (Figure 2) comprises a suite of granitic gneisses, informally named here the Lower Brook metamorphic suite, which is thrust over the gneisses and megacrystic granitoid to the north. The suite preserves relicts of granulite facies metamorphism and locally intrudes the gray, tonalite-granodiorite gneisses.

The drift covered lowlands around Goose Bay have recently been interpreted by Gower *et al.* (*in press*) to form the western end of the late Precambrian - early Paleozoic Lake Melville graben.

Gneisses (Units 1 and 2)

Gray, granitoid gneisses of tonalite-quartz diorite-granodiorite composition (Unit 1). This unit, exposed largely in the northwestern part of the map area, is texturally and compositionally heterogeneous, ranging from hornblende quartz diorite gneiss to hornblende-biotite tonalite and granodiorite gneiss. All types locally contain garnet and are interbanded with amphibolite and amphibolite gneiss, which is locally scapolite bearing. An area of relatively homogeneous, well foliated to weakly gneissic, quartz diorite, which outcrops in the extreme northwest corner of the map area, is designated as subunit 1gd (Figure 2) and forms part of the extensive Susan River quartz diorite of Ryan *et al.* (1982). The Susan River quartz diorite, where locally gneissic, is indistinguishable from many of the gneisses grouped in Unit 1 of this report, but is not necessarily of the same age.

An isolated outcrop area of granitoid gneiss occurs south of the Peters River (subunit 1c) where it is partly enclosed by the younger granitic rocks of Unit 10. These gneisses are strongly banded and migmatitic, generally more so than most of Unit 1, and contain a pink to white, pegmatitic, granite leucosome.

Sillimanite metasedimentary gneiss (Unit 2). Metasedimentary gneiss is disposed in belts infolded with granitoid gneiss in the northwestern part of the area but also occurs as small outcrops in subunit 1c and Unit 10. The metasedimentary gneisses are pink to gray weathering, strongly migmatitic with a pink, pegmatitic, granite leucosome, and are generally tightly folded. They contain the overall assemblage quartz+feldspar+biotite+sillimanite+magnetite/ilmenite garnet. Secondary muscovite is usually present in varying amounts.

The small outcrop area within subunit 1c consists of a similar metasedimentary gneiss but also contains pods of garnet-biotite amphibolite, interpreted as relict dikes.

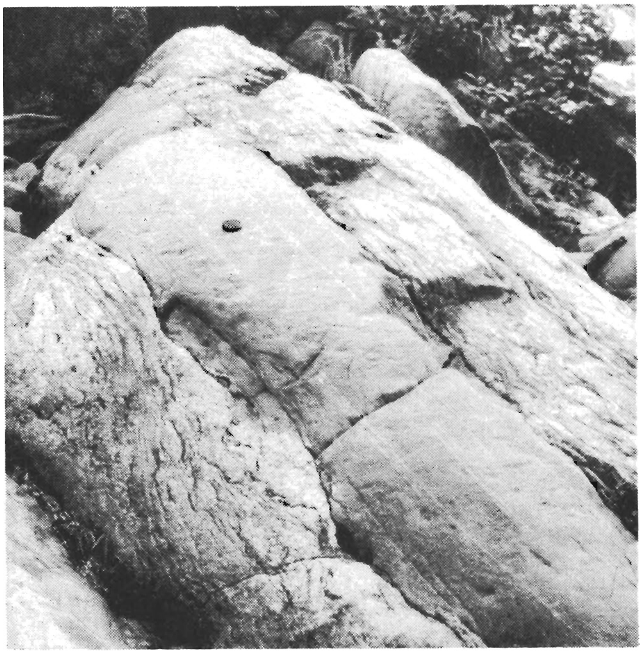


Plate 1: *Dike of gneissic granodiorite in sillimanite metasedimentary gneiss of Unit 2; lens cap is 5 cm in diameter.*

Contacts between metasedimentary gneiss and adjacent units have not been seen. An exposure on the Goose River shows a dike of gneissic granodiorite intruding metasedimentary gneiss (Plate 1), which may indicate an intrusive relationship with at least part of Unit 1. The relatively massive nature of the dike suggests that it may postdate development of the migmatite texture in the host gneiss, however, confirmatory cross-cutting relationships have not been observed.

North West River Anorthositic Intrusive Suite (Units 3 and 4)

Metagabbroid - amphibolite (Unit 3). This unit forms the southwestern limb of a horseshoe-shaped rim of metagabbroid rocks that partially enclose, and also underlie, the anorthosite of Unit 4 (Ryan *et al.*, 1982; Wardle and Ash, 1984). Within the map area, the gabbroid rocks vary from massive to layered in texture and become progressively recrystallized to amphibolite away from the anorthosite. Relict, primary orthopyroxene is locally preserved within metamorphic assemblages of hornblende+plagioclase+clinopyroxene ± garnet. The metagabbroids-amphibolites are also intruded by abundant dikes and sheets of gray monzonite, syenite and granite assigned to Unit 7 (Plate 2), such that 50 percent or more of any outcrop area is likely to consist of granitoid. Ultramafic rocks, generally hornblendites, occur as local enclaves within granitoids of Unit 7 and are presumed to have been part of Unit 3.

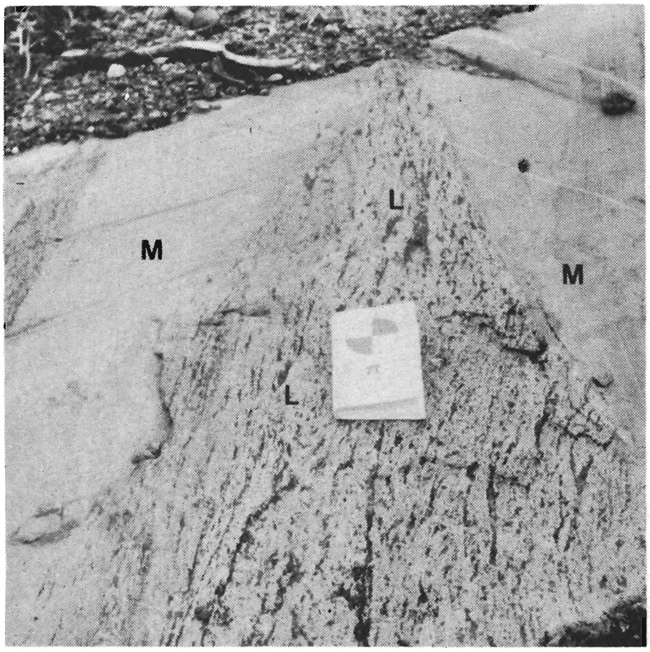


Plate 2: *Foliated leucogabbroid (L) of Unit 3, intruded by foliated sheets of Unit 7 monzonite (M); notebook is 19 cm long.*

The granitoid dikes and sheets generally intrude parallel to the foliation in Unit 3, and appear to be deformed together with that unit. However, at one locality (Plate 3) a foliated monzonite dike contains xenoliths of amphibolite with a strong fabric that clearly predates monzonite intrusion.

Anorthosite (Unit 4). Anorthosite occurs as an extensive massif within the centre of the Cape Caribou River allochthon, and also as a small sliver south of the Peters River, near the western margin of the map area. The part within the allochthon typically comprises coarse to very coarse grained anorthosite and leucogabbroid. Mafic minerals include olivine, orthopyroxene and varying amounts of magnetite and ilmenite. The leucogabbroids locally contain primary olivine, clinopyroxene and orthopyroxene and have compositions ranging from olivine leucogabbro to leuconorite. However, many primary mafic minerals, particularly olivine, are extensively recrystallized to coronal textures with rims of orthopyroxene and symplectic spinel, and are partially replaced by amphibole-biotite intergrowths. More advanced alteration involves recrystallization to secondary clinopyroxene-amphibole assemblages, with the result that the original gabbroid rock type is difficult to identify.

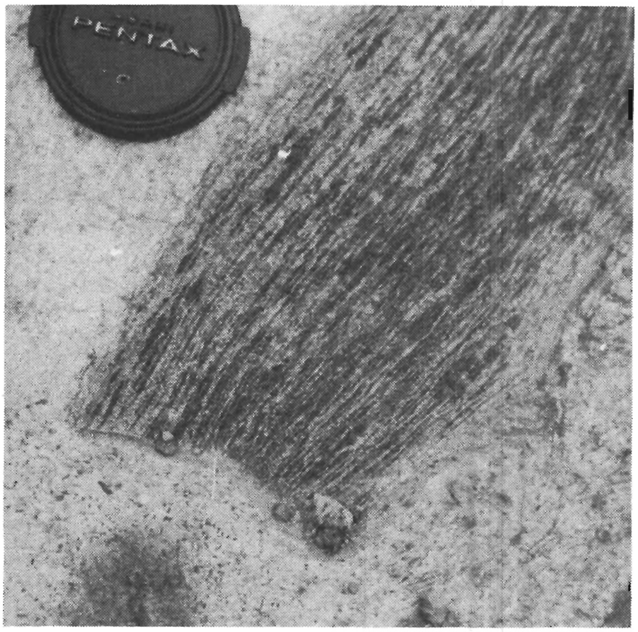


Plate 3: *Xenolith of foliated or lineated amphibolite of Unit 3 in Unit 7 monzonite (the monzonite is strongly sheared to left of picture); lens cap is 5 cm in diameter.*

Layering is commonly present near the contact with Unit 3 where leucogabbroid alternates with anorthosite. Anorthosite in this zone is generally enriched in magnetite. Also, leucogabbroid commonly occurs as elipsoidal pockets within anorthosite, a feature that occurs throughout the unit, but is particularly prevalent near its margins and it is interpreted to result from late-stage crystallization of intracumulate magma pockets. Anorthosite and leucogabbroid generally possess a strong igneous lamination defined by pyroxene and plagioclase.

Igneous texture is generally well preserved within unit 4 and deformation is restricted to narrow mylonitic shear zones. However, large areas of anorthosite near the western margin of the unit are partially recrystallized to a texture in which large, rounded, elongate relicts of giant primary plagioclase crystals 'float' in a matrix of finer grained, secondary plagioclase and variably altered mafic minerals (Plate 4).

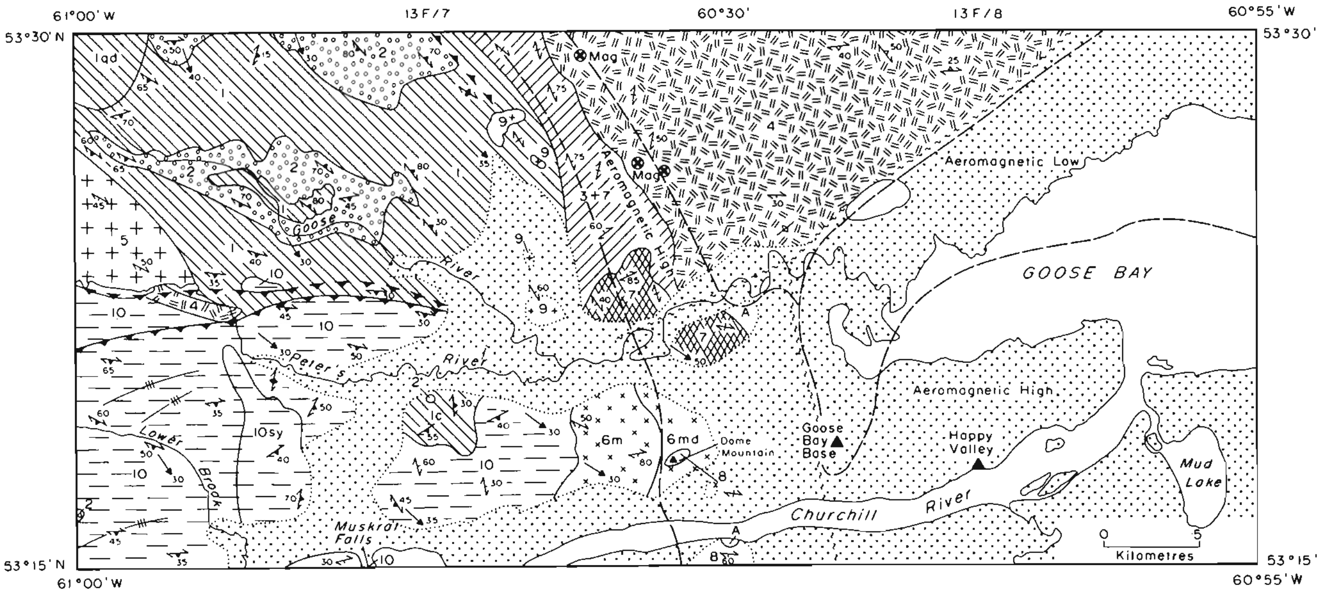
The anorthosite is intruded by numerous metagabbroid dikes, which locally retain chilled margins, but are also extensively recrystallized and folded.

The southwestern contact of Unit 4 is a sharp but gradational contact with Unit 3. The anorthosite is also intruded by dikes of monzonite, granite and pegmatite which are generally similar to those intruding Unit 3.

The small, western sliver of anorthosite is more strongly deformed than the bulk of Unit 4, and it is largely recrystallized to a streaky, banded rock composed of secondary, white plagioclase, and amphibole (Plate 5). Locally, however, a coarse grained texture is preserved as well as the elipsoidal leucogabbroid pockets typical of the main body. The sliver is also similarly intruded by deformed granitoid and pegmatite dikes.

Plate 4: *Recrystallized, coarse grained anorthosite of Unit 4 containing relicts (dark crystals) of giant, primary plagioclase crystals; lens cap is 5 cm in diameter.*

Plate 5: *Strongly foliated and recrystallized, coarse grained anorthosite in the sliver of Unit 4 near the western margin of the map area; hammer is 34 cm long.*



LEGEND

PROTEROZOIC

Foliated, pink granite and granite gneiss; 10sy, syenite and syenite gneiss; includes abundant amphibolite and gray, granitoid gneiss enclaves.

Miscellaneous, small granitoid intrusions.

Dome Mountain Intrusive suite (Units 6 to 8)

Buff, alkali-feldspar granite, syenite and quartz syenite.

Purplish-gray, inequigranular monzonite.

6qm, gray, equigranular quartz monzonite to monzonite; 6md, purplish-gray, equigranular to inequigranular, quartz monzodiorite to monzodiorite.

Gray, megacrystic granitoid.

Amphibolite-metagabbroid enclaves in younger rocks.

North West River anorthositic intrusive suite (Units 3 and 4)

Coarse grained anorthosite-leucogabbroid.

Metagabbroid-amphibolite, locally layered, containing minor hornblendite.

Sillimanite metasedimentary gneiss.

Gray, granitoid gneiss of tonalite-granodiorite composition containing abundant amphibolite and amphibolite gneiss; 1qd, well foliated to weakly gneissic quartz diorite; 1c, well banded, migmatitic, granitoid gneisses.

Figure 3: *Geology of the Goose Bay - Goose River area.*

Amphibolite-metagabbroid (Unit A). Amphibolites and metgabbroids are present as inumerable enclaves of widely varying size within the granitoid rocks of Units 6 to 10. Although only a few of these are large enough to be shown on Figure 3, they nevertheless form an important component which constitutes up to 50 percent of the area indicated as granitoid on Figure 3.

Amphibolite of plagioclase-hornblende garnet composition is the prevalent rock type, typically containing irregular lenticles and seams of hornblendite. Metagabbroid rocks, including leucogabbroid, have ophitic texture and local layering, and grade into amphibolite. Primary pyroxene and rare olivine is also preserved. Ultramafite in the form of hornblendite is a lesser constituent of this unit.

The amphibolites and metagabbroids (Unit A) forming enclaves in Units 6, 7 and 8 appear to be derived from a pre-existing gabbroid plutonic suite. In overall composition and appearance they are similar to rocks of Unit 3, and it is thought that they may represent a southward continuation of Unit 3 that was largely engulfed by granitoid intrusions. This is supported by the aeromagnetic map of the area (GSC, 1970; see also Figure 3), which shows a pronounced, linear, positive anomaly projecting along the strike of Unit 3 southeastward into the Dome Mountain - Goose Bay area. The style in which the metagabbroid rocks of Unit 3 have been intruded by granitoid rocks is also suggestive of stoping, a process which would lead readily to incorporation of large amounts of mafic material into the granitoid plutons.

Amphibolite and metagabbroid rocks within Unit 10 are also locally similar to those seen in Unit 3 but are in general more strongly foliated or gneissic and locally preserve granulite facies metamorphic assemblages. The presence of the anorthosite sliver enclosed within Unit 10 suggests that some of the amphibolite enclaves may derive from associated gabbroid rocks; however other origins are possible including derivation from the gneisses of Unit 1.

Megacrystic granitoid (Unit 5). This unit occupies a triangular area on the western margin of the map area and is a gray, strongly foliated granitoid containing K-feldspar megacrysts set in a matrix of biotite, quartz, plagioclase and minor garnet. Composition varies from granodiorite to granite depending upon the proportion of megacrysts present. Where strongly foliated, the unit becomes an augen gneiss but migmatite texture was not observed. Minor amounts of non-megacrystic granite and amphibolite are also present within the unit.

The contact between Unit 5 and Unit 1, which is exposed in stream valleys on the south side of the Goose River valley, appears transitional and is defined by a gradual disappearance of megacrysts over a distance of several metres. The indistinct nature of the contact is probably due to the general similarity of composition between Unit 1 gneisses and the matrix of the megacrystic granitoid.

Dome Mountain Intrusive Suite (Units 6, 7 and 8)

Monzodiorite, monzonite and quartz monzonite (Unit 6). This unit, as is the case with all components of the Dome Mountain intrusive suite, is heterogeneous with regard to rock type and structure. The western part of the unit (subunit 6qm) is composed predominantly of gray, medium grained, equigranular, hornblende-biotite quartz monzonite and monzonite that are intruded by various types of white to pink granite and pegmatite, including minor amounts of K-feldspar megacrystic granitoid. Rocks vary from massive to foliated (and lineated) and exhibit local zones of incipient migmatization.

The eastern component of Unit 6 (subunit 6md) is largely a purplish-gray, medium grained, hornblende quartz-monzodiorite to monzodiorite characterized by an irregularly developed, weakly porphyritic texture of large K-feldspar crystals set in a dioritic matrix. This unit is also intruded by fine grained monzonite, granite and pegmatite, but is generally less deformed than the western part of Unit 6. Subunit 6md also incorporates several enclaves of a dark, purplish-gray amphibolite containing purple-gray plagioclase and plentiful biotite. These are interpreted as diorites but it is unclear whether they are part of the monzodiorite intrusion or metasomatically altered amphibolites of Unit A.

Monzonite (Unit 7). Monzonite occurs as two separate bodies north and south of the Goose River. It is also compositionally heterogeneous with the predominant rock type being a medium to coarse grained, purplish-gray, inequigranular, hornblende-pyroxene monzonite. Orthopyroxene was identified in one sample; in others, clinopyroxene partially altered to intergrowths of biotite, amphibole, quartz and opaque minerals is the predominant mafic phase, in association with hornblende. K-feldspar forms large crystals, 1 to 2cm in diameter, imparting an inequigranular texture to the rock. The monzonite is also associated with lesser amounts of buff syenite, gray to pink granite, and coarse grained to megacrystic alkali-feldspar granite.

The northern contact of Unit 7 with Unit 3 is of an irregular, interfingering nature, and its position as shown on Figure 3 is very approximate. Dikes and irregular masses of monzonite, syenite and granite that occur throughout Unit 3 are assigned to Unit 7, although they may also include correlatives of other granitoid intrusions, for example Unit 8 syenite and alkali-feldspar granite.

Alkali-feldspar granite, quartz syenite and syenite (Unit 8). Rocks assigned to this unit are concentrated south of the Churchill River but also occur as small bodies in the Dome Mountain area. Unit 8 south of the Churchill River is composed predominantly of buff to pink, medium grained, alkali-feldspar granite with lesser amounts of syenite and quartz syenite. As with all rocks of this unit, the granitoids are distinguished by a dark, gray-green color on broken surfaces. Mafic phases in these rocks consist of primary orthopyroxene and clinopyroxene that are severely altered to hornblende, biotite and opaque minerals. Structural state varies from massive to moderately foliated. The granite also contains numerous enclaves of amphibolite, ultramafite and metagabbroid, some of which appear to have been deformed prior to incorporation in Unit 8.

The small area of Unit 8 located 1.5 km north of the Churchill River comprises weakly deformed, buff, orthopyroxene-hornblende syenite. The crest of Dome

Mountain is formed by strongly foliated to lineated, buff to pink, alkali-feldspar pyroxene-hornblende granite, interspersed with amphibolite enclaves and intruded by aplite. Rusty pyroxene cores are locally recognizable within hornblende crystals, particularly in coarse grained or pegmatitic phases.

Contacts were not observed between Unit 8 and other units. However, the similarity between Unit 8 and the syenite and alkali-feldspar granite phases of Units 6 and 7 suggests a genetic and temporal link.

Miscellaneous small granitic intrusions (Unit 9). These intrusions occupy a number of small outcrop areas in the extensively drift-covered area west of the Cape Caribou River allochthon. Rock types are varied and include pink, fine to medium grained monzonite, quartz monzonite, granite and leucogranite. Structural state varies from weakly to moderately foliated. Contacts with the surrounding gneisses are unexposed but the strong contrast in deformation suggests that the granites postdate the development of the gneissic fabric in Unit 1.

Lower Brook metamorphic suite (Unit 10). This new term refers to a unit of pink foliated granitoids, associated gneisses and amphibolites exposed in the southwestern part of the map area. A small outcrop area around Muskrat Falls is also tentatively included within the unit.

The eastern part of the unit is dominated by pink to white weathering biotite (plus minor hornblende) granites, which vary from strongly foliated to weakly gneissic and migmatitic. To the west, these rocks become progressively gneissic with abundant development of migmatite textures, including lenticular granite leucosomes spotted with hornblende porphyroblasts. Gneissic texture is, however, very variably developed and outcrops of well banded gneiss occur interspersed with areas of less intensely deformed granite. The unit is characterized by an overall granitic composition and pink appearance, and comprises several granitic phases in addition to the ubiquitous pink biotite granites and gneiss. These phases include pale-pink to gray, granodiorite and quartz monzonite together with minor amounts of K-feldspar megacrystic granitoid. They typically occur interbanded on a centimetre to metre scale with pink granitic gneiss.

An important variant of Unit 10 is a subunit of chalky, pink weathering syenite and derived syenite gneiss (subunit 10sy) which underlies a north-trending belt in the centre of Unit 10. The syenites typically contain primary pyroxene that is locally identifiable as clinopyroxene, but in most cases, it is too severely altered to distinguish from orthopyroxene. The syenites and syenite gneisses are cut by concordant and discordant veins containing prominent porphyroblasts of green amphibole, commonly with rusty cores. The cores are thought to be orthopyroxene, however this has yet to be confirmed by petrography.

Amphibolites and metagabbroid enclaves are as common in Unit 10 as in other granitoid units in the area. Amphibolites are generally of hornblende + plagioclase ± garnet composition and are usually present as elongate rectilinear enclaves, which in small exposures are suggestive of mafic dikes. Where present in abundance, these impart a characteristic pink and black layered appearance to the unit. However, in larger outcrop areas such as Muskrat Falls, it is apparent that similar dike-like bodies bear a close spatial relationship to larger, more irregularly shaped pods of coarse grained amphibolite; the enclaves may have been derived from the large bodies by processes of magmatic spalling. Mafic enclaves with the syenite rocks of subunit 10sy locally have a resinous, dark-green to brown appearance and contain the granulite facies assemblage clinopyroxene + hornblende + plagioclase ± orthopyroxene ± garnet. Metagabbroid enclaves are relatively rare but locally preserve primary pyroxene and igneous layering.

Also present within Unit 10 are abundant screens of gray, migmatitic granitoid gneiss, which also contains numerous interbands of amphibolite and amphibolite gneiss. The gray granitoid gneisses are generally well banded with a pegmatitic granitic leucosome fraction that is spotted with hornblende porphyroblasts and minor amounts of rusty orthopyroxene. The most extensive area of gray gneiss is exposed along Lower Brook (Figure 3) where it alternates with bands of pink gneissic granite. Amphibolites within the gneisses locally contain clinopyroxene and orthopyroxene, and are generally similar in appearance to those preserved within the syenitic gneisses.

The origin of the gray gneiss screens is problematical. Larger enclaves, such as that exposed in Lower Brook, are similar in general appearance to gneisses of Unit 1, and might be interpreted as derived from that unit. However, crosscutting relationships necessary to confirm this interpretation have not been found. Many of the smaller gray gneiss screens are interbanded with granitic gneisses on a scale of 0.5 to 2 m, and it is equivocal as to whether they represent earlier gneisses or highly metamorphosed granodiorite phases of Unit 10.

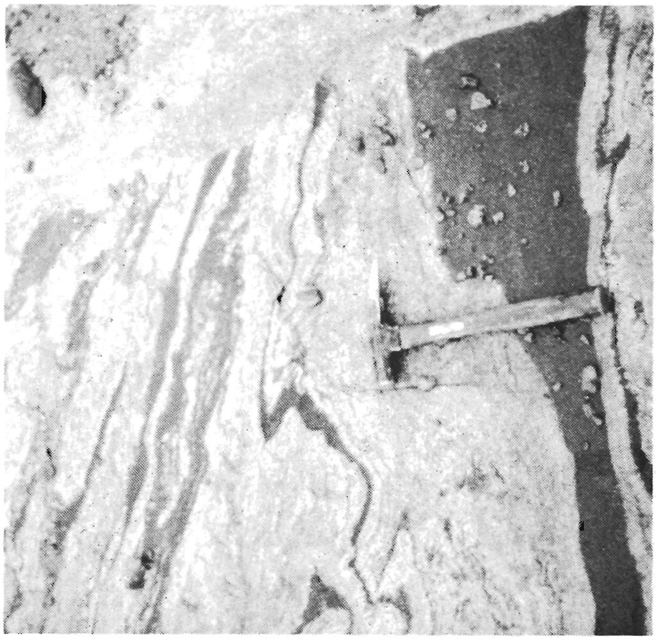


Plate 6: *Banded granitoid-amphibolite gneiss of subunit 1c intruded discordantly by foliated, nebulitic granite of Unit 10 (top); hammer is 34 cm long.*

Foliated to schlieric and nebulitic granites of Unit 10 intrude the gneiss of subunit 1c as concordant and discordant sheets (Plate 6). Relationships with other units are uncertain. The northern margin of Unit 10 is marked by a major south-dipping ductile shear zone, within which the granite gneisses and their amphibolite enclaves are converted to thinly layered, black and pink, mylonitic gneisses.

Minor intrusions. Amphibolite exposed in the Goose River between the two halves of Unit 7 monzonite is intruded by a fresh, posttectonic, 3 m wide diabase dike trending 018 . Granitoid rocks of Unit 6 in the vicinity of Dome Mountain are intruded by thin dikelets of fine grained, posttectonic granite for which a parent pluton has not been identified.

Tectonic Development

On the basis of structural trends (Figure 3), the area is divided into a northern domain dominated by northwest-trending fabrics, and a southern domain characterized by approximately west-trending fabrics. The two are separated by drift cover and the ductile shear zone forming the northern boundary of Unit 10.

Foliations in the northern domain are generally steep and are refolded about southeast-plunging second folds associated with a colinear mineral lineation. The annular outcrop pattern of the belt of Unit 2, immediately north of the Goose River, is suggestive of an interference pattern produced by large scale refolding of an early structure about southeast-plunging second fold axes; a pattern which is consistent with the geometry of the minor second fold structures. The pattern could also be interpreted as a sheath fold, however, minor sheath or 'eye' folds have not been seen in association with the structure.

Mapping to the north of the map area by Ryan *et al.* (1982) revealed that the northwestern margin of the Cape Caribou River allochthon is bounded by a major, mylonitic, ductile shear zone with a shallow, southeasterly dip (Figure 2). On Figure 3 this zone is inferred to extend into the map area as a lateral thrust ramp. However, of the few scattered outcrops seen in this area, none show evidence of pervasive mylonitization. Therefore, it is evident that any southerly extension of the thrust must be a very narrow zone that is obscured by drift.

Foliations in the northern domain become re-oriented into east-west trends near the ductile shear zone that marks the northern boundary of Unit 10. The shallow, southerly dip and strong, southeast-plunging lineation of this structure are taken to indicate that it is a zone of northwest-directed thrust movement. Several pronounced topographic linears in the south, some of them associated with mylonite, are interpreted to mark the site of subsidiary thrusts.

Foliations in the southern domain are largely of east-west trend and moderate to shallow, southerly dip. Lineations and associated minor fold axes plunge moderately to the southeast and are colinear with those in the northern domain. It is evident, therefore, that although trends of foliation and ductile shear zones vary considerably throughout the map area, the direction of tectonic transport, as deduced from second-phase structures, was consistently to the northwest.

The intensity of deformation and metamorphism, as signified by the development of gneissic and migmatitic textures, increases from east to west within the map area. Rocks of the North West River anorthositic intrusive suite within the Cape Caribou River allochthon become strongly foliated to the west, but never gneissic or migmatitic, a state which contrasts sharply with the banded, migmatitic texture of Unit 1 at the base of the allochthon. Ryan *et al.* (1982) have discussed evidence suggesting that gabbroic rocks discordantly intrude granitoid gneisses near the base of the allochthon on its northwest margin. However, field evidence to corroborate this interpretation is lacking from the present map area.

A problem is also posed by the relationship depicted in Plate 3 wherein a xenolith of foliated or lineated amphibolite (Unit 3) is incorporated in zonally deformed monzonite of Unit 7. The implication of this relationship is that the metagabbroid component (Unit 3) of the North West River anorthosite intrusive suite underwent an early period of deformation prior to monzonite intrusion. However, this relationship has only been observed at one locality and its regional significance is, as yet, unclear.

The Dome Mountain intrusive suite shows a progradation from largely massive textures in the east to strongly foliated, locally gneissic and migmatitic textures in the west, a trend that is continued within the rocks of the Lower Brook metamorphic suite, which also become progressively gneissic to the west. There is at present no evidence for a metamorphic hiatus between the Dome Mountain and Lower Brook suites. However, the Lower Brook suite granites discordantly intrude the gneisses of subunit 1c, and it must be concluded that at least in this southern part of the map area, there is evidence for two periods of high-grade metamorphism, both associated with migmatization. The Lower Brook metamorphic suite also preserves relicts of a granulite facies metamorphism in enclaves of possibly earlier rocks; however, the bulk of the suite appears to have been affected only by amphibolite facies metamorphism, although this has yet to be confirmed in all areas.

In summary, there is limited field evidence suggesting that formation of at least part of the Unit 1 gray gneiss terrane predated intrusion of the major plutonic suites of the area. However, it is probably an oversimplification to regard all parts of Unit 1 as being necessarily of the same age, or as having formed during the same period of metamorphic development. The unit shows considerable internal variation in metamorphic state and it is quite possible that some of its more massive parts (such as subunit 1qd - Susan River quartz diorite) could be equivalent in age to rocks in the North West River, Dome Mountain and Lower Brook suites.

Postorogenic tectonism is represented by development of the Lake Melville graben, of suspected late Precambrian-early Paleozoic age. Details regarding interpretation and development of the structure are given in Gower *et al. (in press)*. The northern boundary fault of the structure is inferred to lie along the base of the linear escarpment marking the southeastern edge of the anorthosite. Some of the brittle crushing and shearing that occur in outcrops along the escarpment may be attributable to graben faulting, however, no systematic fracture pattern of northeasterly trend was noted.

The western boundary fault of the graben is inferred entirely on the basis of aeromagnetic evidence (GSC, 1970). The linear positive anomaly which extends southeastward from Unit 3 metagabbroids (Figure 3) has a very steep gradient on its northeastern side, inferred to be the site of the fault.

The aeromagnetic map also shows the southeastern side of the graben to be underlain by a broad positive anomaly, which slopes gradually north into a deep low along the northwestern side of the graben. It is speculated that the magnetic high represents a northward extension of monzonites of the Mealy Mountains intrusive suite (Emslie, 1976), which are generally characterized by a positive magnetic expression (GSC, 1971), and that the magnetic low may either represent foundered anorthosite, or more tentatively, late Precambrian red beds of the Double Mer Formation, which forms the graben fill in areas to the northeast (Kindle, 1924; Erdmer, 1984; Gower *et al., in press).*

MINERALIZATION

The area formed part of the BRINEX Labrador concessions and was prospected during the 1950's and 1960's. It was later included in a reconnaissance airborne-spectrometer program by Hudbay Uranium Ltd. (Fenton, 1977), and also included in the National Geochemical Reconnaissance Program (GSC, 1977).

Minor amounts of ilmenite are found in association with magnetite in the anorthosite of Unit 4. Magnetite forms pronounced concentrations, both as an intercumulus phase and as veins, in a zone of anorthosite near the basal contact between Unit 4 and Unit 3. This zone underlies the crest of the pronounced, positive, aeromagnetic anomaly that follows the contact of the anorthosite and Unit 3 metagabbroids, suggesting that the area may contain larger concentrations of mineralization. Small concentrations of ilmenite were also found within pegmatitic phases in Unit 2 metasedimentary gneiss.

Douglas (1976) reported a small quartz-vein occurrence of chalcopyrite on the west side of Dome Mountain; however this showing was not found during our work.

The anorthosite of Unit 4, although displaying local labradorescence, is generally strongly fractured and partially recrystallized, thus severely limiting its potential as gem or dimension stone.

ACKNOWLEDGEMENTS

Field work was carried out with the assistance of Memorial University students Greg Pittman, Karen Roberts and Brenda Hewitt. Helicopter services were ably provided by Sealand Helicopters Ltd. of Goose Bay. An initial draft of this report was critically reviewed and much improved by Bruce Ryan.

REFERENCES

Douglas, C.
1976: Mineral occurrence tables, Labrador. To accompnay Mineral Occurrence Map of Labrador (Map 761). Newfoundland Department of Mines and Energy, Mineral Development Division, Open File [Lab 326].

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

Erdmer, P.
1984: Precambrian geology of the Double Mer - Lake Melville region, Labrador. Geological Survey of Canada, Paper 84-18, 37 pages.

Fenton, J.O.
1977: Final report on project generation uranium, Labrador project area. Hudbay Uranium Ltd. Unpublished Report. Open File [Lab. 421].

Fulton, R.G. and Hodgson, D.A.
1969: Surficial geology of the Goose Bay 1:250,000 sheet (13F). Geological Survey of Canada, Open File, 16 maps.

Geological Survey of Canada
1970: Aeromagnetic maps 1″=1 mile Goose Bay (13F/8) and Goose River (13F/7) areas. Geological Survey of Canada, aeromagnetic maps 6042 (13F/8) and 6043G (13F/7).

1971: Aeromagnetic map 1″=4 mile, Goose Bay (13F). Geological Survey of Canada, aeromagnetic map 7391G.

1977: National geochemical reconnaissance, uranium reconnaissance program maps. Geological Survey of Canada, Open File 510.

Gower, C.F.
1984: Geology of the Double Mer White Hills and surrounding region, Grenville Province, eastern Labrador. *In* Current Research, Part A, Geological Survey of Canada, Paper 84-1A, pages 553-561. *Also in* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 84-1, pages 68-79.

Gower, C.F., and Owen, V.
1984: Pre-Grenvillian and Grenvillian lithotectonic regions in eastern Labrador - correlations with the Sveconorwegian Orogenic Belt in Sweden. Canadian Journal of Earth Sciences, Volume 21, pages 678-693.

Gower, C.F., Erdmer, P. and Wardle, R.J.
1986: The Double Mer Formation and the Lake Melville rift system, eastern Labrador; description, age and tectonic significance. Canadian Journal Earth Sciences. *In Press.*

Kindle, E.M.
1924: Geography and geology of Lake Melville district, Labrador Peninsula. Geological Survey of Canada, Memoir 141, 104 pages.

Low, A.P.
1897: Report on exploration in the Labrador Peninsula along the Eastmain, Koksoak, Hamilton, Manicouagan and portions of other rivers. Geological Survey of Canada, Annual report L, 1895, Volume VIII.

Ryan, A.B., Neale, T. and McGuire, J.
1982: Descriptive notes to accompany geological maps of the Grand Lake area, Labrador 13F/10, 11, 14, 15.

Newfoundland Department of Mines and Energy, Mineral Development Division, Maps 82-64 to 82-67.

Scott, H.S., and Conn, H.K.
1949: Geology of the Goose Bay area, Labrador. Unpublished report to Geological Divsion, Photographic Survey Corporation. Open File [13F/1].

Stevenson, I.M.
1967: Goose Bay map-area, Labrador. Geological Survey of Canada, Paper 67-33, 12 pages.

Wardle, R.J., and Ash, C.
1984: Geology of the North West River area. *In* Current Research. Mineral Development Division, Department of Mines and Energy, Newfoundland and Labrador, Report 84-1, pages 53-67.

Note: Mineral Development Division file numbers are included in square brackets.