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GEOLOGY OF THE GOOSE–PINUS RIVERS AREA (13F/3, 4, 5 and 6), CENTRAL GRENVILLE OROGEN, LABRADOR

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ABSTRACT

Mapping in 1987 focused on the metasedimentary gneiss terrane, which forms much of the Grenville Orogen in central Labrador, and its contact with other lithotectonic terranes to the east and south. The greater part of the map area is underlain by monotonous metasedimentary gneiss disposed in a major overturned structure referred to as the Pinus Synform. In the northeast, this gneiss, intruded by sheets of megacrystic granite, structurally overlies tonalite, granodiorite, quartz diorite and related gneiss of the Susan River quartz diorite and Groswater Bay terrane. In the south, it is infolded with and overthrust by granitic gneiss and amphibolite interpreted to form the northwestern margin of the Mealy Mountains terrane.

Early deformation of Labradorian (ca. 1650 Ma) and/or Grenvillian (ca. 1000 Ma) age was associated with formation of subhorizontal gneissic and migmatitic fabrics under amphibolite- to granulite-facies conditions. Subsequent deformation, probably of Grenvillian age, consisted of isoclinal folding and formation of south-dipping, ductile shear zones. Metamorphic assemblages and associated migmatization suggest similarly high-grade metamorphic conditions. Late Grenvillian deformation produced open folds and basin and dome interferance patterns.

Grenvillian deformation was followed by deposition of the upper Precambrian to lower Paleozoic Double Mer Formation in a graben interpreted to underlie the Churchill River valley. Quartzite clasts in conglomerates of the formation were probably derived from a nearby, but now eroded, middle Proterozoic sequence similar to those of the Seal Lake and Wakeham Bay groups.

It is concluded that all major lithotectonic terranes in the Goose Bay region were linked by common plutonic sequences prior to the Grenvillian Orogeny, though the absolute ages of these terranes and their linkages have yet to be determined.

INTRODUCTION

The area mapped in the 1987 season lies in the interior Grenville Province of central Labrador (Figure 1) where it adjoins ground covered to the east by previous work under this project (Wardle and Ash, 1986; Wardle and Crisby, 1986). The central and southwestern part of the area form a poorly exposed undulatory plateau largely covered by muskeg and glacial drift. The northern and eastern parts are deeply dissected by the Goose, Pinus and Churchill rivers and consequently form rugged and more completely exposed ground. Mapping was carried out by helicopter-emplaced ground traverses in well-exposed areas, and by helicopter traverses in more poorly exposed regions.

The area was first mapped in 1953 (Podolsky, 1955), at a time when it formed part of a mineral concession held by the Newfoundland and Labrador Corporation (Gillet, 1954). Podolsky (1955) recognized that areas north of the Churchill River (Figure 2) were dominated by quartzofeldspathic gneiss, including sillimanite gneiss, whereas the area south of the river consisted of a syenodiorite complex. The presence of a major synform in quartzofeldspathic gneiss north of the river was also noted. Stephenson (1967) included the area in his mapping of the Goose Bay region for the Geological Survey of Canada and confirmed the presence of the synform. He also indicated a belt of gabbroic and monzonitic rocks south of the Churchill River, and conglomerate of the upper Precambrian to lower Paleozoic Double Mer Formation along its banks. Surficial deposits of the area were described by Fulton and Hodgson (1969) in their regional geomorphological study of NTS sheet 13F.

Work on the present project began as part of a three year program designed to complete mapping at 1:100,000 scale of the Goose Bay sheet. Results have been reported in Wardle and Ash (1986) and Wardle and Crisby (1986, 1987).

REGIONAL SETTING

The Goose Bay area lies within the interior Grenville Orogen (Figure 1) and forms part of a belt of high-grade gneiss and plutonic rock. These rocks have given metamorphic and intrusive ages of 1700-1650 Ma that record the effects of the Labradorian Orogeny (Nunn *et al.*, 1985). The rocks were reworked and given their present structural disposition in the Grenvillian Orogeny ca. 1000 Ma.

The Grenville Orogen of eastern Labrador has been divided into several major lithotectonic terranes (Gower and

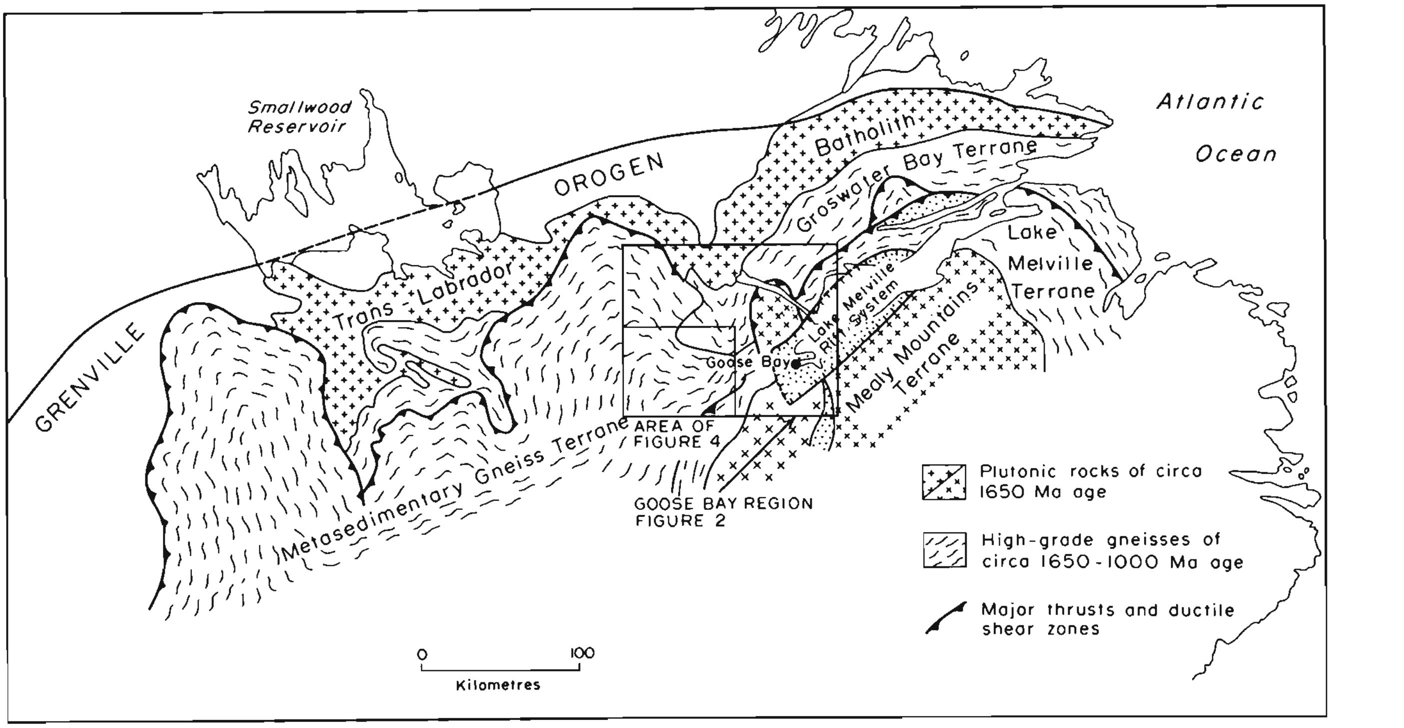


Figure 1. *Location of the map area with respect to tectonic elements of the northeastern Grenville Orogen.*

Owen, 1984; Wardle *et al.*, 1986a) that converge in the Goose Bay region (Figures 1, 2 and 3), making it a focal point for establishing tectonic interrelationships in the interior Grenville Orogen. Granitoid rocks of the Trans-Labrador batholith, dated ca. 1650 Ma, project into the north of the region (Figures 2 and 3). They are adjoined to the east by the extensive Susan River quartz diorite and derived gneiss (Ryan *et al.*, 1982) that pass eastward into similar intrusive rock and granitoid gneiss of the Groswater Bay and Lake Melville terranes (Gower and Owen, 1984). The Lake Melville terrane is overthrust to the south by granodiorite–tonalite gneiss, metagabbro and anorthosite of the Cape Caribou River allochthon (Ryan *et al.*, 1982). This allochthon was proposed by Wardle *et al.* (1986b) to form an extension of the regionally extensive Mealy Mountains terrane, which underlies the southeastern part of the region (Figures 2 and 3). The Mealy Mountain terrane comprises weakly deformed monzonite, metagabbroid rock and anorthosite (Wardle and Crisby, 1987) that is dated to the east of the region at 1640 Ma (Emslie *et al.*, 1983; U–Pb zircon). The Mealy Mountain terrane passes northwestward into a suite of granite and amphibolite gneiss known as the Lower Brook suite, which has been proposed to represent its metamorphosed northern margin (Wardle and Crisby, 1987). The western part of the region is underlain by an extensive suite of metasedimentary gneiss, referred to here as the metasedimentary gneiss terrane. This terrane extends more than 300 km to the west (Figure 1), and is thrust over the Trans-Labrador batholith. The area mapped in 1987 includes the eastern and southern boundaries of the metasedimentary terrane with the Susan River quartz diorite and Mealy Mountains terrane respectively.

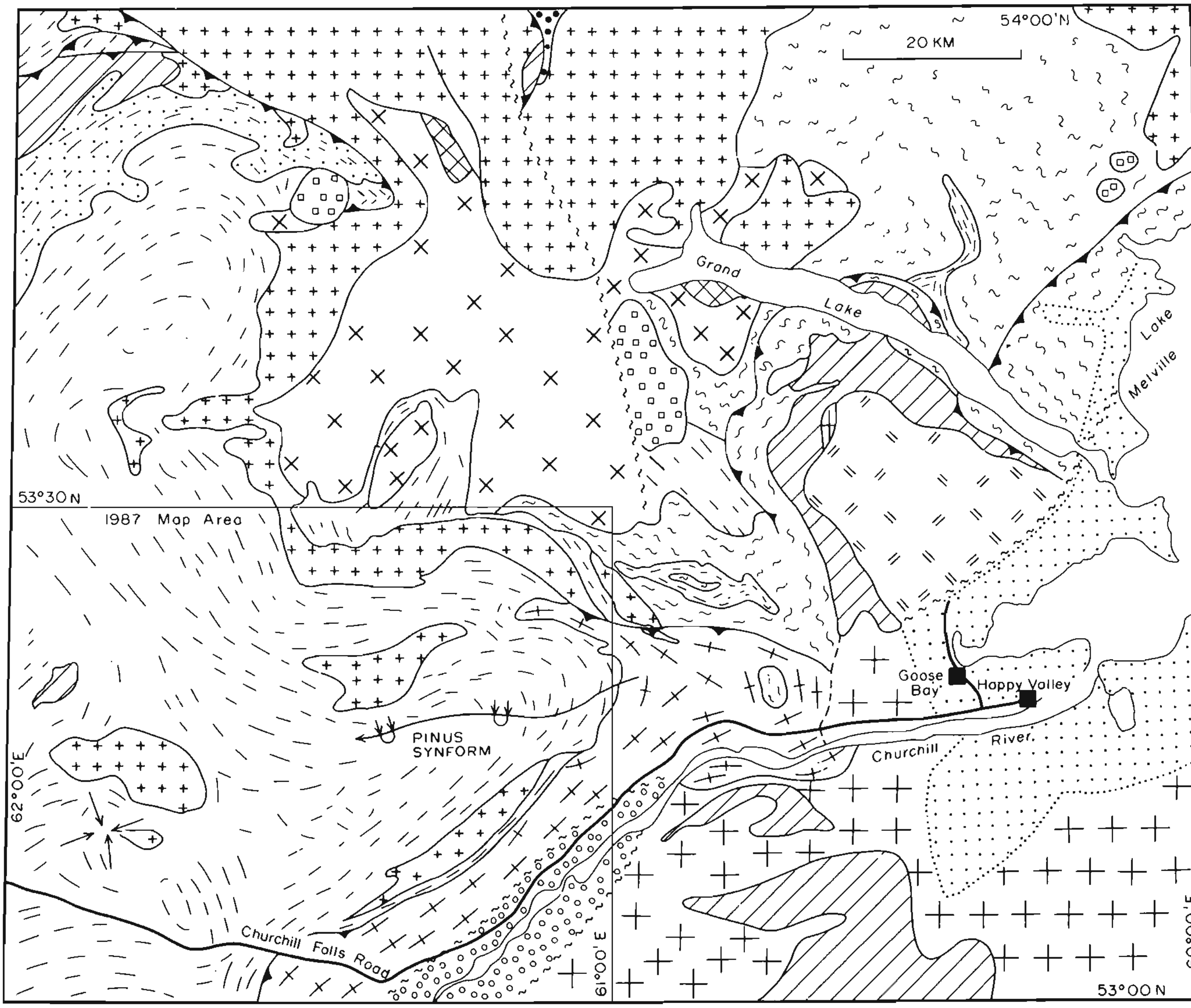
Post-Grenvillian development in the region is represented by the upper Precambrian–lower Paleozoic Lake Melville Rift System (Figure 3; Gower, *et al.*, 1986) and associated Double Mer Formation.

GEOLOGICAL DESCRIPTION

Metasedimentary Gneiss (Unit 1)

These rocks, which occupy most of the map area (Figure 4), are divided into three subunits on the basis of field appearance. Subunit 1a comprises a generally grey, banded and migmatitic quartz–feldspar–biotite gneiss and also contains ilmenite and variable amounts of garnet. Sillimanite is locally present as isolated needles or acicular sprays, and indicates a psammitic to semipelitic origin for the bulk of subunit 1a. However, some outcrop areas are formed by relatively massive quartz–feldspar–biotite gneiss that could conceivably be derived from granite, or felsic volcanic rock. Rocks of presumed granitoid origin are present as small outcrop areas of grey, plagioclase-porphyritic granodiorite augen gneiss, prevalent near the contact with Lower Brook suite gneiss. The bulk of subunit 1a is disposed as a discontinuous band around the rim of the Pinus Synform (Figure 4) where it appears to represent a vestige of megascopic stratification.

Subunit 1b forms the bulk of the metasedimentary gneiss and consists of generally pink, migmatitic to banded gneiss of quartz–feldspar–biotite–sillimanite–garnet–ilmenite composition. This sillimanite-rich gneiss is locally intercalated with thin bands of grey sillimanite-deficient gneiss similar to subunit 1a. Contacts are generally gradational and



QUATERNARY

Glacial, fluvioglacial and estuarine deposits

UPPER PROTEROZOIC–LOWER PALEOZOIC

Double Mer Formation: *sandstone and conglomerate*

MIDDLE PROTEROZOIC

Monzonite, quartz monzonite and gabbro plutons (1307 Ma)

Seal Lake Group: *quartzite (1320 Ma)*

LOWER AND/OR MIDDLE PROTEROZOIC

Lower Brook metamorphic suite: *granitic gneiss and amphibolite*

Mealy Mountains and Dome Mountain intrusive suites: *monzonite–granite*

LOWER AND/OR MIDDLE PROTEROZOIC *(Continued)*

Trans-Labrador batholith and associated plutons: *includes granite–quartz monzonite and megacrystic granitoid rock and gneissic equivalents*

Metadiorite

North West River anorthositic suite: *anorthosite*

Gabbroid–metagabbroid plutonic rocks and amphibolite equivalents

Susan River quartz diorite: *foliated to gneissic quartz diorite*

Banded, migmatitic quartz diorite–tonalite–granodiorite gneiss

Beaver gneiss: *mafic (supracrustal ?) gneiss*

Migmatitic sillimanite–kyanite metasedimentary gneiss; includes part of Disappointment Lake gneiss

Figure 2. *Regional geology of the Goose Bay area (13F). The 1987 map area forms the southwestern quadrant.*

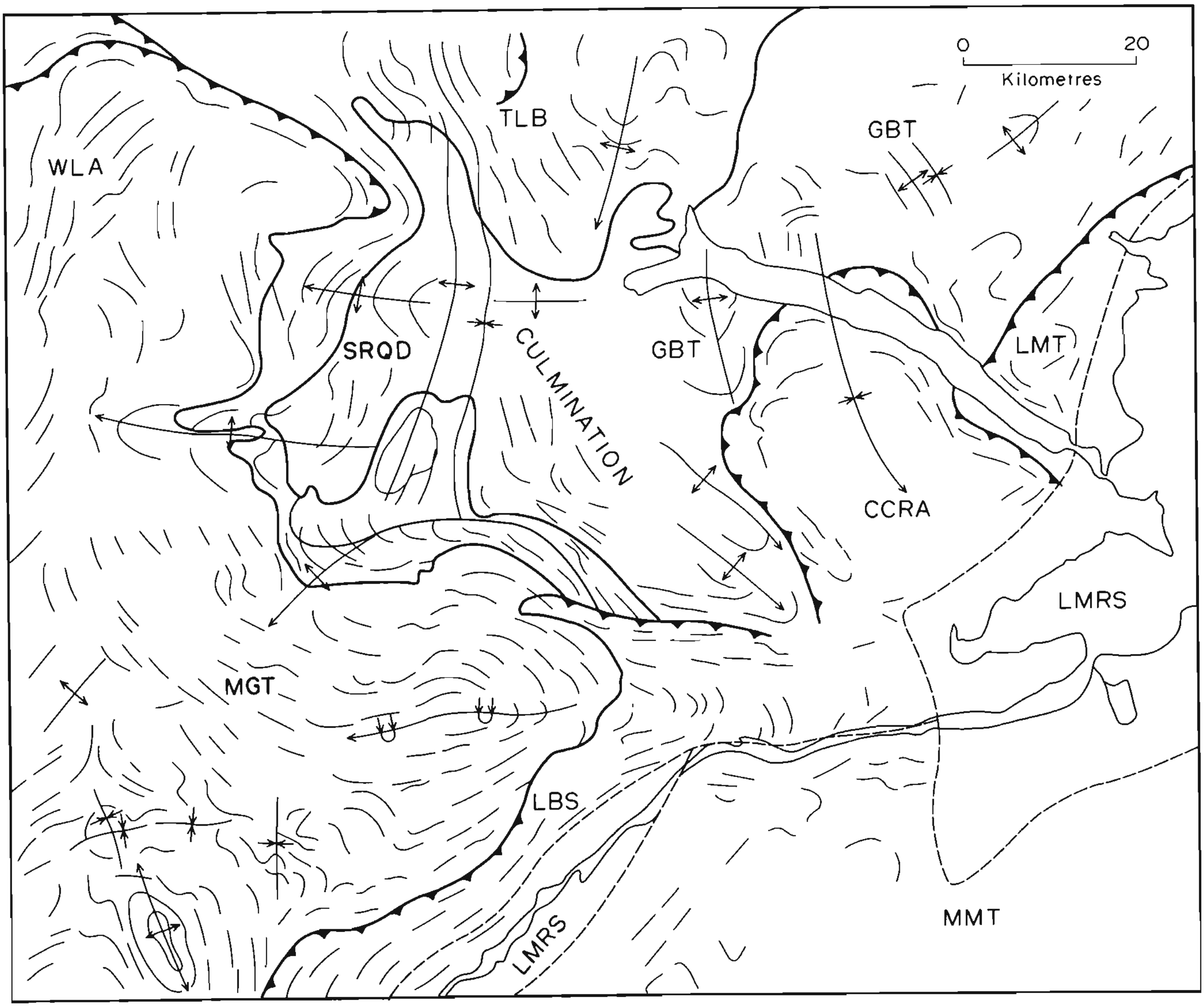


Figure 3. *Major tectonic subdivisions of the Goose Bay area (13F) combined with structural trends. MGT=metasedimentary gneiss terrane; WLA=Wilson Lake allochthon; TLB=Trans-Labrador batholith; SRQD=Susan River quartz diorite; GBT=Groswater Bay terrane; LMT=Lake Melville terrane; CCRA=Cape Caribou River allochthon; MMT=Mealy Mountains terrane; LBS=Lower Brook suite; LMRS=Lake Melville Rift System. Simplified after Ryan* et al., *1982; Thomas* et al., *1983; Erdmer, 1984; Wardle and Ash, 1984; Wardle and Crisby, 1986.*

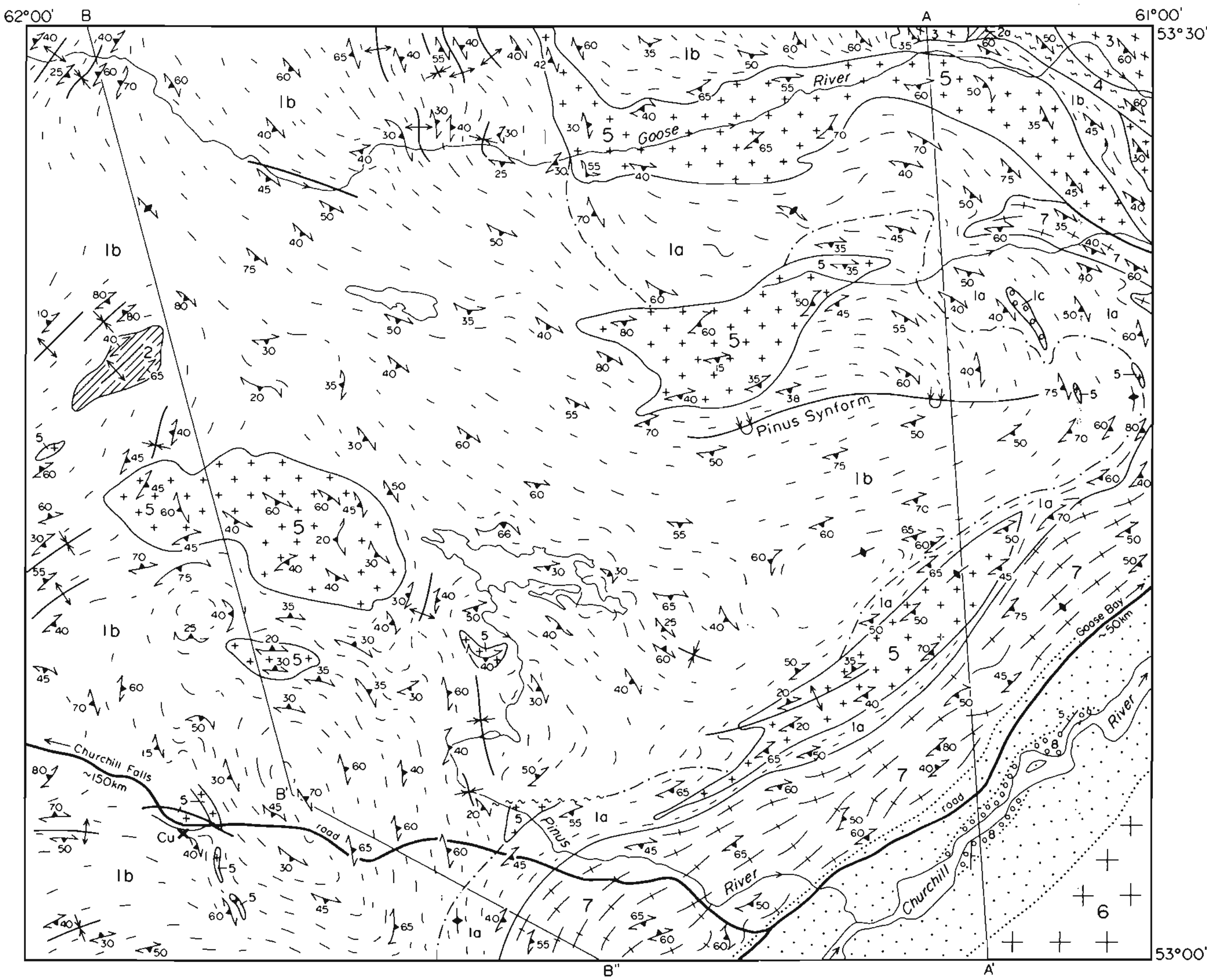
it is likely that the grey gneiss represents psammitic (alumina deficient) layers within the sedimentary protolith.

Subunits 1a and b both contain numerous thin boudinaged bands and isolated pods of hornblende–plagioclase amphibolite likely derived from minor intrusions and mafic volcanic rocks. Banded diopside-bearing calc-silicate rock and angular boulders of white marble (likely of local derivation) have also been found within an area largely underlain by metasedimentary gneiss in the southwestern part of the map area.

Subunit 1c is a small lenticular augen gneiss body of enigmatic origin exposed near the nose of the Pinus Synform. The unit is texturally similar to metasedimentary gneiss, apart from the presence of small (1 to 1.5 cm) K-feldspar augen. Similar rocks are also seen adjacent to contacts with megacrystic granite of Unit 5.

Areas of diatexite, locally identified as separate granite intrusions in previous work (Podolsky, 1955; Stephenson, 1967) are also common over areas of several tens to hundreds of square metres within all variants of Unit 1. They are composed generally of weakly foliated, equigranular to pegmatitic granite containing garnet, biotite, ilmenite, minor clots of sillimanite, and schlieren of metasedimentary gneiss.

The age of the metasedimentary gneiss within the map area has not been established directly. The gneiss is, however, continuous to the northwest with the similar Disappointment



LEGEND

PLEISTOCENE

8 — *Fluvioglacial sand and clay*

UPPER PROTEROZOIC–LOWER PALEOZOIC

8 — Double Mer Formation: *cobble–boulder quartzite conglomerate and red sandstone*

MIDDLE–LOWER PROTEROZOIC

7 — Lower Brook metamorphic suite: *pink to grey granitic gneiss, and amphibolite*

6 — Mealy Mountains intrusive suite: *weakly foliated monzonite and monzodiorite*

5 — *Foliated to gneissic, K-feldspar-megacrystic granitoid rocks*

4 — *Grey, migmatitic quartz–feldspar–biotite granodiorite–tonalite gneiss*

MIDDLE–LOWER PROTEROZOIC *(Continued)*

3 — Susan River quartz diorite: *grey, quartz–feldspar–biotite–hornblende–garnet quartz diorite*

2 — *Amphibolite–mafic granulite;* 2a *ultramafite and amphibolite gneiss*

Metasedimentary gneisses

1c — *Quartz–feldspar–biotite augen gneiss*

1b — *Pink, quartz–feldspar–biotite–garnet–sillimanite gneiss (sillimanite rich)*

1a — *Grey, quartz–feldspar–biotite–garnet gneiss (local sillimanite)*

SYMBOLS

60 — *Ductile shear zone*

—·— *Gradational contact*

Figure 4. *Geology of the Goose–Pinus rivers area (13F/3, 4, 5 and 6).*

Lake gneiss that has yielded dates of ca. 1650 Ma (Thomas *et al.*, 1986).

Amphibolite–Mafic Granulite (Unit 2)

This unit occurs as two mappable bodies (Figure 4) and several widely scattered outcrops interspersed within metasedimentary gneiss of Unit 1. The western body consists of hornblende–plagioclase amphibolite, containing local relict orthopyroxene, intruded by granitoid dykes and pegmatite. Relict orthopyroxene, in association with clinopyroxene, is also found in small outcrops of similar rock type scattered through the north-central part of the map area. The northeastern body (subunit 2a; Figure 4) underlies a small area of deeply weathered schistose ultramafite of uncertain composition, which is associated with isolated outcrops of amphibolite gneiss. The nature of the relationship between the mafic rocks and metasedimentary gneiss is unknown.

Susan River Quartz Diorite and Tonalite (Unit 3)

This unit is present in the northeast of the map area and is contiguous to the north with the regionally extensive Susan River quartz diorite (which also includes diorite, granodiorite and granite) of Ryan *et al.* (1982) (Figure 2). The western part of this unit, north of the Goose River, comprises dark grey, and massive, plagioclase–quartz–biotite–hornblende–garnet intrusive rock of quartz diorite–diorite composition. Biotite defines a strong foliation but the rocks are not generally gneissic. The eastern part of the unit is more heterogeneous in composition, varying from quartz diorite to tonalite and granodiorite (generally containing very little garnet), but is likewise characterized by foliated or lineated, as opposed to gneissic, texture. Ryan *et al.* (1982) noted an intrusive relationship between Susan River quartz diorite and metasedimentary gneiss; however, the absolute age of the plutonic suite has yet to be established.

Granitoid Gneiss (Unit 4)

Unit 4 is spatially associated with Unit 3 and forms a narrow band separating its eastern and western components. It is composed of well-banded quartz–feldspar–biotite gneiss containing minor amounts of hornblende and garnet, and ranges in composition from quartz diorite to granodiorite. The gneiss is identical to more extensive rocks found to the east within the Groswater Bay terrane (Figures 2 and 3), and also resembles gneissic parts of the Susan River quartz diorite (*sensu lato*; Ryan *et al.*, 1982), from which it may in part be derived.

Megacrystic Granitoid Rock (Unit 5)

Megacrystic granitoid rock occurs as several podiform or sheet-like plutons within the metasedimentary gneiss and as scattered plutons too small to be shown in Figure 4. Individual plutons differ substantially in degree of deformation but show broadly similar compositions and are grouped for purposes of description. The northernmost pluton, exposed around the Goose River, forms part of the Trans-Labrador batholith. The unit as a whole is dominated by grey-weathering granitoid rocks containing K-feldspar megacrysts set in a granoblastic to foliated matrix of quartz, plagioclase feldspar, biotite, oxides (predominantly ilmenite) and minor garnet. The composition is principally granitic but varies to granodiorite in megacryst-poor outcrops. Lesser amounts of medium grained, equigranular granite are present, and the Goose River pluton includes a marginal phase consisting of quartz-rich megacrystic granite (1 to 2-cm megacrysts).

The structural state of the unit varies from weakly foliated, in which megacrysts are randomly orientated, to strongly foliated, in which gneissic, migmatitic and mylonitic textures predominate. Foliation is defined by quartz and biotite. In strongly deformed rocks, the megacrysts have recrystallized to augen composed of granoblastic K-feldspar aggregates. Development of foliation, in particular mylonitic fabric, is generally more intense in the southwestern part of the area.

Contacts between Unit 5 and the metasedimentary gneiss of Unit 1 are exposed at several localities on the Goose and Pinus rivers. Some contacts are sharp; most, however, are gradational due to development of small K-feldspar augen (imparting a pseudogranitoid appearance) within metasedimentary gneiss and almost complete recrystallization of megacrystic texture within the granitoids. Augen gneiss, derived from megacrystic granitoid, is repeatedly intercalated with metasedimentary gneiss (Unit 1) in bands several metres to tens of metres in width along a section of the Pinus River extending 4 km upstream of the contact with the Lower Brook suite (Figure 4). The strong deformation and mylonitic texture suggest that this feature is tectonic.

Monzonite–Monzodiorite of the Mealy Mountains Intrusive Suite (Unit 6)

This unit is confined to the area southeast of the Churchill River (Figure 4) where it adjoins an extensive mass of similar rocks correlated by Wardle and Crisby (1987) with the Mealy Mountains Intrusive Suite. Within the map area this suite is represented predominantly by grey- to brown-weathering, medium grained monzonorite, biotite monzodiorite and lesser amounts of gabbronorite, altered metagabbroid and pink monzonite. The metagabbroid rocks are locally seen as inclusions in monzodioritic rocks whereas monzonite appears to be a late phase on the basis of dykes seen to intrude monzodiorite. The suite as a whole contrasts with all other rocks in the map area by virtue of its massive to weakly foliated state. The only indication of its age comes from the eastern Mealy Mountains area from where Emslie *et al.* (1983) have obtained a U–Pb zircon age of 1640 Ma.

Granite Gneiss and Amphibolite of the Lower Brook Metamorphic Suite (Unit 7)

This unit forms a 10-km-wide band between the metasedimentary gneiss of Unit 1 and the massive intrusive rocks of Unit 6, and is correlated with the Lower Brook suite of Wardle and Ash (1986). Granitic gneiss and amphibolite are the dominant rock types within the present map area. The granitic gneiss is a grey- to pink-weathering, weakly to strongly layered rock type containing biotite, hornblende, garnet and clinopyroxene in addition to quartz and feldspar. Layering in the gneiss is largely defined by granite–amphibolite variation and *lit-par-lit* migmatite texture. The pink-weathering colour is clearly a secondary effect associated with late fracturing and is most prevalent near the Churchill River valley.

Migmatite fabrics are locally crosscut by foliated granite dykes and posttectonic pegmatite. The igneous parentage of the granitic gneiss is readily demonstrated in local low-strain areas that preserve homogeneous granite–quartz monzonite containing relict equigranular igneous texture and amphibolite xenoliths.

Amphibolite, consisting of plagioclase+hornblende± clinopyroxene and garnet, is interlayered with granitoid gneiss on a scale of centimetres to metres and may locally form up to fifty percent of outcrop. Scarce enclaves of a coarse grained, leucocratic metagabbroid rock, similar to rock types seen within the gabbroid–anorthosite sequence of the Cape Caribou River allochthon, are also found within the Lower Brook suite.

The contact between the Lower Brook suite and the metasedimentary gneiss is a ductile shear zone, except within the nose of the Pinus Synform. Generally, gneissic layering within the Lower Brook suite has a straight appearance parallel to the contact, and within the shear zone gives way to pink and black, banded, mylonite and ultramylonite gneiss. The shear zone obscures primary relationships between the Lower Brook suite and other map units. However, to the east (Wardle and Ash, 1986) equivalent rocks pass gradationally into foliated plutonic rocks intrusive into tonalite–granodiorite gneiss at the base of the Cape Caribou River allochthon.

Conglomerate and Sandstone of the Double Mer Formation (Unit 8)

Stevenson (1967) described two outcrops of conglomerate and sandstone on the banks of the Churchill River that he correlated with the Double Mer Formation of the Lake Melville area. Despite an extensive search, these two outcrops remain the only exposure of this unit in the map area. Both comprise cobble to boulder conglomerate consisting almost exclusively of quartzite clasts set in a matrix of coarse pink arkose, which is locally cemented by carbonate. The clasts are highly rounded, white to pale green, and very fine grained. They are clearly of sedimentary origin but also show a pervasive recrystallization and weakly developed cleavage that indicate metamorphism of the source lithology. The conglomerate and arkose are crossbedded in tabular sets for which a northwesterly paleocurrent flow is indicated by three measurements. The environment of deposition can only be broadly interpreted as either littoral or fluviatile.

The conglomerate is undeformed and must therefore lie unconformably upon the surrounding rocks. Conglomerate exposures are topographically lower than those of adjacent gneiss and granitoid units, and indicate preservation in an old river channel or a graben. The lack of local detritus in the conglomerate suggests isolation from local sources at time of deposition and is more compatible with the latter interpretation. Klassen and Thompson (personal communication, 1987) have noted abundant rounded quartzite boulders, identical to those described above and inferred to be of local derivation, in tills extending 100 km to the east of the area. This strongly suggests that the conglomerate is the fault-preserved remnant of a preglacially extensive unit. At present, the only quartzite sequences with which the conglomerate and till boulders can be matched are in the middle Proterozoic Seal Lake and Wakeham groups (Brummer and Mann, 1961; Bourne *et al.*, 1977). However, these are relatively distal (more than 100 km), whereas the homogeneity of clast content suggests a proximal source. Presumably, therefore, the conglomerate clasts were derived from a now eroded local quartzite source, which shed detritus into Double Mer fluvial systems during post-Grenville uplift. The Double Mer rocks were subsequently preserved in a graben associated with development of the Lake Melville Rift System (Gower *et al.*, 1986).

STRUCTURE AND METAMORPHISM

Early structural development in the area involved the development of gneissic and migmatitic layering under upper-amphibolite-facies conditions in both metasedimentary and granitoid gneisses. Relict orthopyroxene in mafic rocks indicates the local attainment of granulite-facies conditions in the north-central and southwestern parts of the area. It is uncertain whether early fabric development occurred coevally in all units.

Gneissic fabrics in all rock types, but particularly in the metasedimentary gneiss, have been refolded into tight folds in a second deformational (D_2) event. This was associated with the development of a weak biotite S_2 fabric and a west- to southwest-plunging intersection lineation. A second generation of partial melt is locally seen forming thin veins along the axial planes or limbs of D_2 folds. In D_2 high-strain zones, common throughout the metasedimentary gneiss, the folds become isoclinal, develop a strong biotite–sillimanite fabric, and eventually suffer complete transposition into a composite S_1–S_2 fabric. Also, as part of this process, lineation is converted from an intersection to a mineral aggregate lineation, defined by quartz, feldspar and biotite, and progressively rotated into south to southeasterly plunge directions. D_2 deformation culminated in the formation of ductile shear zones, which are localized within the metasedimentary gneiss, at some of its contacts (see below) and within megacrystic granite. This deformation, which is prevalent in the southwestern part of the area, resulted in development of straightened and mylonitic gneiss. Sillimanite in such rocks is aligned within the S-fabric plane but randomly orientated on the S-surface, and only forms a mineral lineation in the most strongly sheared and mylonitic rocks.

The major D_2 ductile shear zones form the contact between metasedimentary gneiss and Lower Brook suite

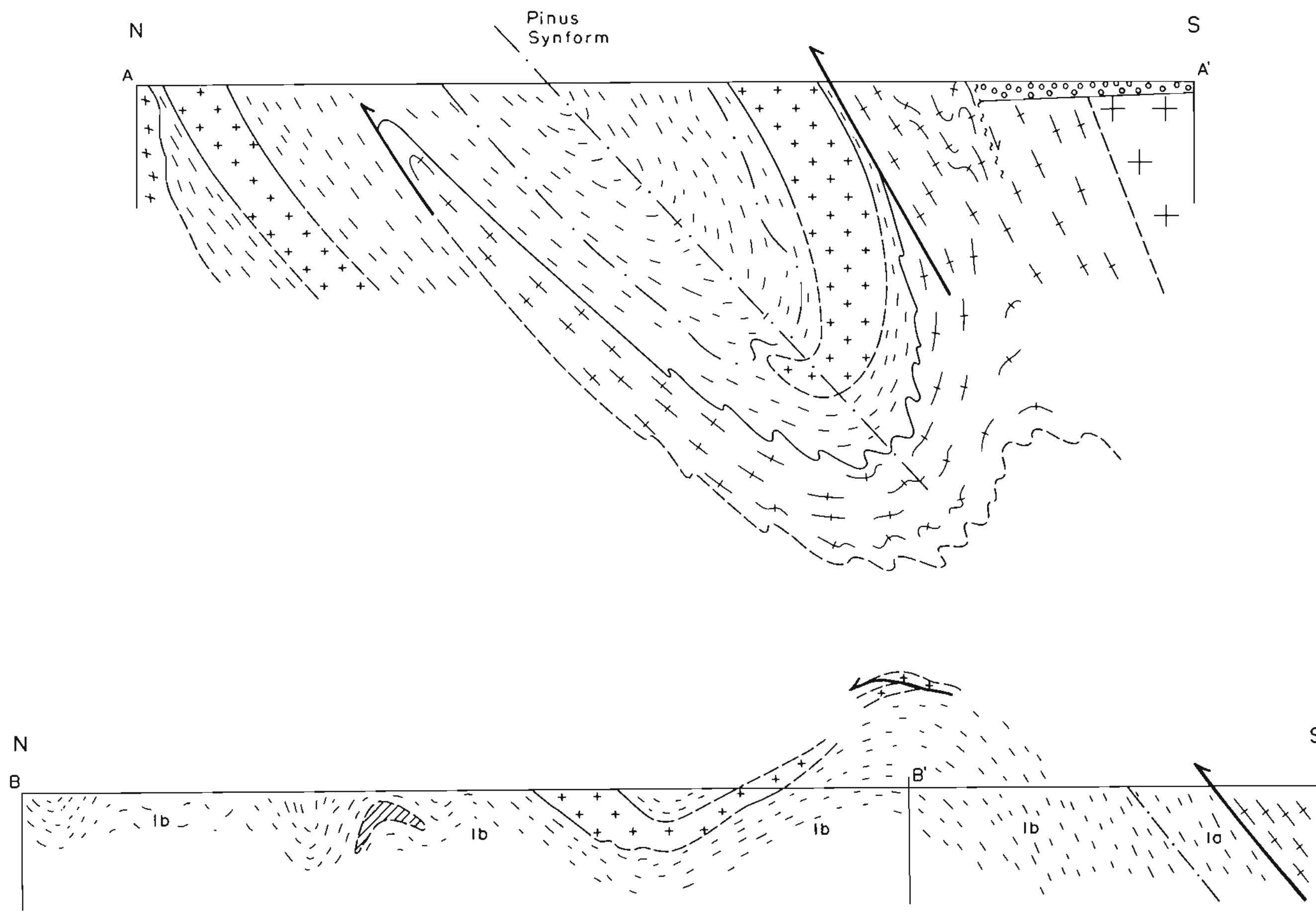


Figure 5. *Structural cross-sections of Goose–Pinus rivers area. Sections are keyed to Figure 4.*

gneiss on the limbs of the Pinus Synform (Figures 4 and 5). Fresh orthopyroxene, in association with clinopyroxene, is locally present in amphibolite–mafic granulite bands within mylonitic Lower Brook gneiss adjacent to both shear zones. Other major shear zones are undoubtedly present within the southwestern part of the area, but, with the exception of a shear zone exposed on the Churchill Falls road, a combination of poor exposure and late folding has prohibited their full delineation. D_2 melt veins and local orthopyroxene in the Lower Brook suite imply that D_2 ductile shearing occurred under upper-amphibolite- to granulite-facies conditions. The random orientation of sillimanite on S-surfaces indicates that the thermal peak of this metamorphism outlasted deformation except within the central parts of some shear zones where the mineral forms a lineation.

The only megascopic fold structure that can be reasonably linked with the D_2 event is the Pinus Synform. This overturned isocline (Figure 5; Section A-A') has a steep southwesterly plunge coincident with the plunge of intersection lineation in minor folds. The presence of the synform is only apparent in its closure region, raising the possibility that other major isoclines may be present in more poorly exposed parts of the map area.

Following shear-zone development, the area was subjected to a period of open folding about irregular but approximately north- and east-trending axes that locally interfered to produce dome and basin patterns (Type 1; Ramsay, 1967). These structures, which affect shear-zone fabrics, F_2 folds and lineation, are most pronounced in the southwestern part of the area, probably because D_2 fabrics in this area had a prior subhorizontal attitude making them sensitive to subsequent folding (Figure 5; Section B-B").

The late folds are correlated with regional structures of similar trend described by Ryan *et al.* (1982) from the area to the northeast. These folds to the northeast are associated with a culmination of Susan River quartz diorite and tonalite–granodiorite gneiss (Figure 3). All structures in the northeastern corner of the present map area have westerly to southerly dips and plunges off this culmination.

In the eastern part of the map area, the latest structures are a series of steep, brittle faults of east to northeast trend that are parallel to well-developed drainage and air photograph lineaments. Faults are locally exposed as narrow zones of brecciation and hematite–silica–epidote–chlorite alteration. The granitoid gneiss of the Lower Brook suite near the

Churchill River is particularly strongly fractured and reddened as a result of this faulting. Fault development is most likely related to development of the upper Precambrian (to lower Paleozoic) Lake Melville Rift System and its Churchill River valley splay, and alteration is probably related to the ingress of oxidizing groundwater from the Double Mer erosion surface.

MINERALIZATION

Mineralization is restricted to a small occurrence of chalcopyrite associated with calc-silicate and sillimanite gneiss in the southwestern part of the area. Podolsky (1955) also reported chalcocite from biotite granite (diatexite of this study) within approximately the same area. Metasedimentary gneiss throughout the map area also contains small scattered concentrations of disseminated ilmenite.

DISCUSSION

The most important aspects of field work in 1987 are the confirmation of the synformal structure first recognized by Podolsky (1955), and the realization that this structure, together with late cross folds, reveals down-plunge sections through a layered part of the Grenvillian crust. The sections show that the metasedimentary gneiss is interlayered with a sheet-form pluton of megacrystic granite and a folded apophysis of Lower Brook suite gneiss and that these lithologies structurally overlie the Susan River quartz diorite and equivalent Groswater Bay terrane gneiss. Whether this has any primary stratigraphic significance is doubtful. Prior to late folding it is likely that most of the gneissic and D_2 fabric elements had subhorizontal or gentle south-dipping attitudes, suggesting an association with nappe-style tectonics. It is thus possible that the observed sequence is entirely the result of structural as opposed to depositional or intrusive control.

U—Pb zircon dating of granulite- and amphibolite-facies gneiss from the remainder of the metasedimentary gneiss terrane of central and western Labrador has yielded largely Labradorian (ca. 1650 Ma) ages (Thomas *et al.*, 1986). Therefore, it is likely that much of the metasedimentary gneiss in the map area, including the retrogressed mafic granulites of Unit 2, was initially metamorphosed to amphibolite-granulite facies in this event. The age of the major shear zones, and by inference the whole D_2 event, is likely to be Grenvillian by comparison with major shear zones along the northern boundary of the metasedimentary gneiss terrane dated at 1046-1088 Ma (Dallmeyer, 1987) (Figure 3). The D_2 event was at least locally associated with partial melting and similar upper-amphibolite- to granulite-facies metamorphism. Consequently, it is unclear to what extent the metamorphic state of the area as a whole is the result of Grenvillian, as opposed to Labradorian, tectonism.

One of the original aims of the Goose Bay project was to elucidate the relationship between the Mealy Mountains terrane and lithotectonic terranes to the north. Evidence collected to date suggests that the Lower Brook suite gneiss represents the metamorphosed northwestern margin of the Mealy Mountains terrane and also that this terrane is connected by intrusive relationships to the Cape Caribou River allochthon. The Mealy Mountains terrane (including the Lower Brook suite) and Cape Caribou River allochthon are bounded on their northwestern sides by a major thrust front of probable Grenvillian age. This front, however, is not a single, continuous structure, but a series of individual thrusts which die out, or root, along strike. Thus gneiss of the Groswater Bay terrane may be traced around the western side of the Cape Caribou River allochthon into similar gneiss forming the basal part of the allochthon, where it is intruded by granitoid plutons contiguous with the Mealy Mountains terrane (Wardle and Crisby, 1987). It is evident, therefore, that Groswater Bay terrane was plutonically linked to the Mealy Mountains terrane prior to Grenvillian deformation.

The contact between the Mealy Mountains terrane (including the Lower Brook suite) and the metasedimentary gneiss terrane is largely tectonic and original relationships have not been deduced. However, to the north of this contact zone, the metasedimentary gneiss terrane is intruded by the Trans-Labrador batholith and Susan River quartz diorite (Ryan *et al.*, 1982). Both of these plutonic units are also in intrusive contact with rocks of the Groswater Bay terrane (although relative age relationships are not clear) and thereby provide indirect evidence of a pre-Grenvillian linkage between the metasedimentary and Mealy Mountains terranes.

The age of the various terranes of the Goose Bay region and their plutonic linkages is still uncertain and is being addressed through a program of radiometric dating. However, it appears reasonably clear that most of the crustal elements of this region were in place by 1000 Ma and that the principal effect of Grenvillian deformation was to rework this crust at high metamorphic grade and telescope it into a series of northwest-verging thrust blocks.

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