GEOLOGY OF THE ATIKONAK RIVER AREA, GRENVILLE PROVINCE, WESTERN LABRADOR [1]

Nunn, G.A.G. and Christopher, A., Geology of the Atikonak River area, Grenville Province, western Labrador; in Current Research, Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-1, p. 107-114, 1983.

Also in Current Research, Part A. Geological Survey of Canada, Paper 83-1A, p. 363-370, 1983.

Abstract

The map area lies within the Grenville Province immediately southwest of Churchill Falls in western Labrador. An area of paragneiss within the Grenville Province is correlated with similar supracrustal rocks of Aphebian age to the west. Posttectonic intrusion by granitoid and gabbroid rocks, tentatively correlated with the Paleohelikian North Pole Brook Intrusive Suite and the Shabogamo Intrusive Suite respectively, indicate that initial deformation of the paragneiss was Hudsonian or early Paleohelikian. A zone which might contain the approximate continuation of the Hudsonian front in the Grenville Province is suggested.

Introduction

This report presents the results of the first part of a two year co-operative program between the Geological Survey of Canada and the Newfoundland Department of Mines and Energy. The aim of the project is to elucidate the stratigraphy and tectonic evolution of the Atikonak River area in western Labrador. The project area includes NTS map areas 23H/1, 2, 7 and 8 (Fig. 51.1). These were mapped at 1:100 000 scale using helicopter support.

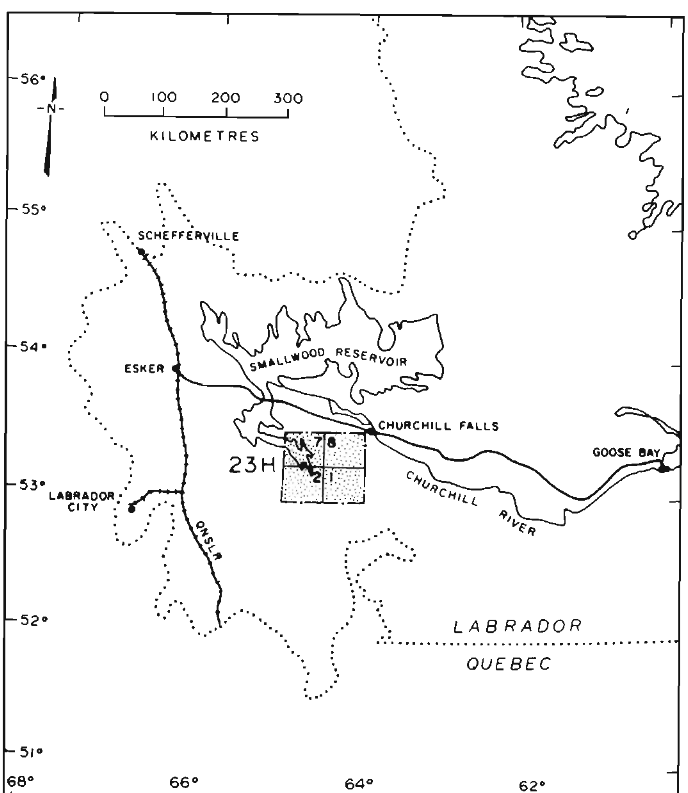

Figure 51.1. *Location map of the Atikonak River area, western Labrador.*

The physiography of the area is dominated by Ossokmanuan Lake, a flooded area that forms part of the Smallwood Reservoir. No correction for flooding has been made to the map. Access to the western part of the area is from Ossokmanuan Lake, the Atikonak River or a road from Churchill Falls to the power transmission line. Access to the remainder of the area is by helicopter.

Previous Work

Earlier work in the area comprises reconnaissance mapping by Eade (1952) at 1:126 720 scale, and Wardle (1982). Eade described an older complex of granitic paragneiss, gabbroic gneiss, amphibolite and garnet-, biotite-, and chlorite-bearing schist, intruded by younger, undeformed gabbro. Greene (1972, 1974) divided the granitic paragneisses into those with assumed Aphebian or older parentage in the west and those of supposed Helikian origins in the east. Smyth and Green (1976) positioned the northern boundary of the Grenville Province in the area giving it a lobate form separating the two gneissic groups of Greene (1972) within the Grenville Province from a re-entrant underlain by undeformed gabbro that was excluded from the Grenville Province.

Wardle (1982) noted that both western and eastern lobes were apparently the same assemblage of polydeformed and migmatized sillimanite-bearing paragneiss that was subsequently intruded by pre- and late-tectonic granitoid plutonic rocks. Wardle (1982) interpreted the gabbroic gneisses of Eade (1952) as deformed equivalents of the younger gabbro and considered that the whole area lay within the Grenville Province.

General Geology

The map area (Fig. 51.2) is divided into two metamorphic terranes that coincide with peneplain levels at 875 m and 680 m. The upper peneplain is underlain by granulite facies rocks, the lower one by amphibolite facies rocks. Locally a mylonite has been mapped at the contact between the two facies and the boundary is assumed to be a thrust fault.

Unit 1 (Fig. 51.2) is composed of strongly migmatized sillimanite-bearing paragneiss at granulite and upper amphibolite facies and is the oldest lithology recognized in the map area. Retrogression is of only minor significance and occurred late during the Grenvillian Orogeny. Neither Wardle (1982) nor the writers find sufficient reason to separate the amphibolite and garnet-, biotite- or chlorite-bearing schist unit of Eade (1952) although amphibolite (metagabbro of unit 3) and biotite-garnet paragneiss (unit 1) are minor lithologies near Ossokmanuan Lake.

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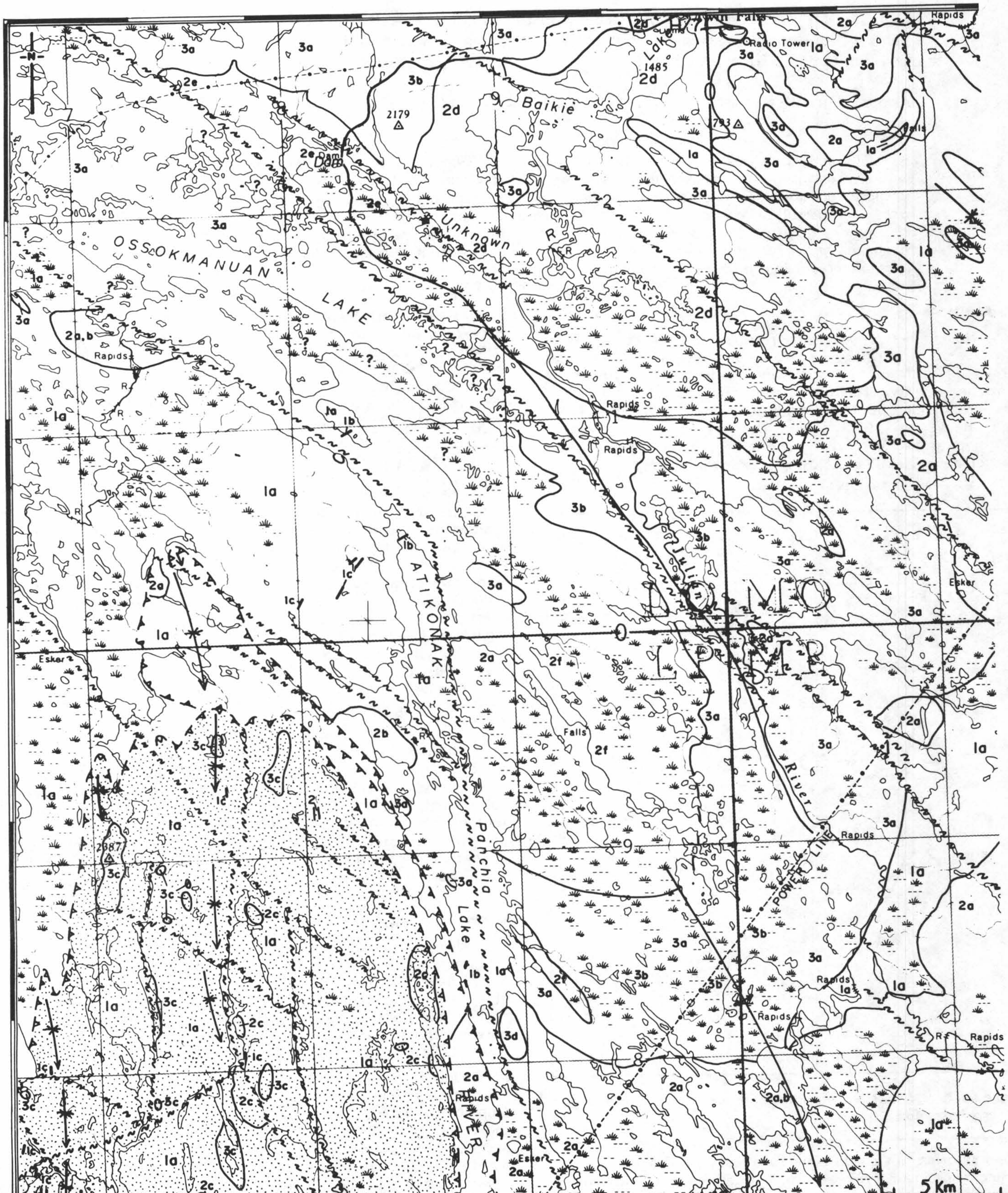
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RIVER
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Falls
Esker
2179
1793
1485
2087
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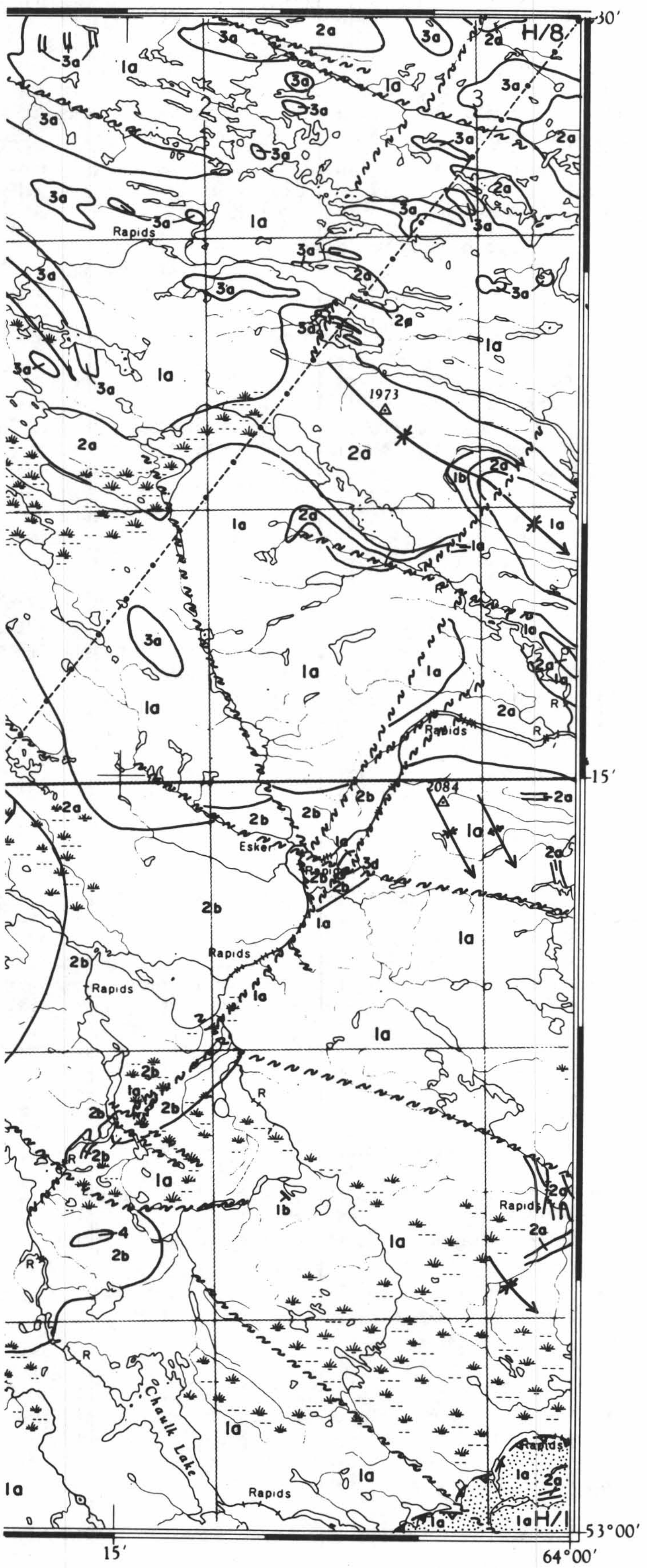

LEGEND

NEOHELIKIAN ?

Unit 4. White, very coarse grained muscovite granite.

PALEOHELIKIAN ?

Unit 3. Shabogamo Intrusive Suite?:

- **3a** Fine- to coarse grained, intergranular textured gabbro and leucogabbro and their amphibolite facies metamorphosed equivalents, commonly with coronas; minor pegmatite;
- **3b** fine- to coarse-grained, layered gabbroic rocks and their amphibolite facies metamorphosed equivalents;
- **3c** fine- to medium-grained, equigranular, granulite facies leucogabbro with minor gabbro, ultramafic rock and anorthosite; minor intergranular textured gabbro and fine grained dykes.

Unit 2. Orthogneiss and foliated granitoid rocks: Possible equivalents of the North Pole Brook Intrusive Suite (Thomas and Hibbs, 1980).

- **2a** grey, fine- to medium-grained, static textured, granodioritic and tonalitic rocks, variably migmatized ranging from homogeneous to lit-par-lit layered, granite or trondhjemite leucosomes;
- **2b** grey, megacrystic granodiorite, groundmass fine-to medium-grained, static textured; coarse porphyritic to fine porphyroblastic microcline megacrysts;
- **2c** buff, medium- to coarse-grained, strongly foliated, microcline porphyritic, quartz monzonite;
- **2d** grey, medium grained, sphene-rich, microcline porphyritic, quartz monzonite; moderately to strongly foliated and migmatized;
- **2e** pink, fine-to medium-grained, granite layered, granodioritic gneiss; very strongly migmatized;
- **2f** pink, fine- to medium-grained, statically recrystallized, biotite granite and aplite, rarely weakly migmatitic.

APHEBIAN

Unit 1. Paragneiss.

- **1a** pink, granite migmatite banded; either strongly foliated sillimanite + opaque oxide ± minor biotite restite or statically recrystallized sillimanite + biotite + garnet restite;
- **1b** thin, discontinuous quartzite, and subarkosic and arkosic arenite;
- **1c** fine grained, pyroxene-bearing basic gneiss, probably supracrustal with minor dykes;
- **1d** fine grained, pyroxene-bearing metabasic rocks in amphibolite facies areas.

SYMBOLS

Geological contact (assumed)

Thrust, teeth on upthrust block (assumed)

Fault and major photo lineaments (assumed)

Fold axis – GD_4; anticline, syncline (assumed)

Granulite facies

? Uncertain, dominantly drift covered areas

Figure 51.2. *Generalized solid geology of the Atikonak River area.*

Unit 1 has been intruded by a plutonic suite (unit 2) consisting of granitoid rocks ranging in composition from diorite to granite.

Unit 3 consists of a variety of gabbroic rocks including rocks correlated with the Paleohelikian Shabogamo Intrusive Suite, a major intrusive feature of the northern Grenville Province in western Labrador.

Unit 4 comprises late syntectonic to posttectonic granite dykes (not shown on the map) and a small, very coarse grained body of muscovite granite. Widespread development of late Grenvillian intrusions was not found during this study. Several minor units previously considered Grenvillian (Wardle, 1982) are thought to be a part of unit 2.

No age dates are available for rocks within the map area.

Unit 1: Supracrustal Gneisses

Unit 1 is composed of paragneiss, and minor metabasic supracrustal rocks which are mostly confined to the southwestern portion of the map area. Bulk compositional variation within the paragneiss is rare suggesting a homogeneous protolith.

Migmatitic paragneiss (unit 1a). The paragneiss includes pinkish brown and grey banded rocks in which partial melting has produced a location fabric[1] of alternating layers of granitic melt and aluminous restite, and several generations of crosscutting migmatitic granite veins. Layering representing the initial melt is pink to brown weathering, several millimetres to one centimetre thick and forms the most regular banding. It is composed of fine- to medium-grained quartz + feldspar ± biotite ± opaque oxides ± garnet ± sillimanite. The restite occurs as 0.5-3 mm thick, white to grey foliae composed of either sillimanite + biotite + magnetite ± garnet, or sillimanite + opaque oxides ± a fine grained biotite selvage. Paragneiss with biotite-rich restite occurs only in northern and northeastern parts of the area. Kyanite has been recorded from the northern margin of the area (Wardle, 1982). Later generations of migmatitic veins are pink, medium grained, 1-2 cm thick and consist of microcline + quartz + plagioclase + biotite ± magnetite ± garnet. Wherever this later migmatization is well developed the restite is more prominent. Crosscutting dykes composed of biotite or two-mica granite are also present.

In places the rock forms an inhomogeneous diatexite with patches of restite within areas of coalesced melt. Gradations occur between the isotropic granitoid-looking migmatite and the layered migmatitic gneiss. The gradational rocks usually contain palimpsest structures and the areas of coalesced melt appear to have remained in situ. However, nebulitic, sheet-like examples of the diatexite indicate local mobility as dykes.

Homogeneous sedimentary layers (unit 1b). Locally, homogeneous, nonmigmatitic layers occur intercalated with the main paragneiss. They consist of quartz + feldspar ± biotite ± opaque oxides and appear to have been derived from arkosic to quartz arenites. Thin layered quartzites are also present and commonly occur as trains of boudins or as thin layers associated with amphibolite. A thick, folded quartzite layer is present in the east of map area H/8.

Metabasic rocks (unit 1c). Basic gneiss is interlayered with the paragneiss in the western part of map area H/2, and includes a few layers, several tens of metres thick, and abundant thinner, less continuous layers, enclaves, and trains of boudins. The thicker layers are net-veined or sheeted by granitoid material. The basic gneiss consists of plagioclase + orthopyroxene + diopside + hornblende; a quartz-rich segregation layering is common. In the eastern part of the area the metabasic rocks (amphibolite) are much less abundant than in the southwest. The intimate intercalation of the basic gneiss with paragneiss, including quartzite, appears primary and indicates that the metabasic rocks are probably of volcanic origin.

Other thinner, boudinaged metabasic layers, which locally preserve relict porphyritic texture and fine grained margins, are derived from mafic dykes.

The age of unit 1 has not been determined directly. However, the paragneiss is contiguous with lithologically similar rocks that extend over 100 km to the west into the Wabush area (T. Rivers, personal communication, 1982). There, Rivers (1980) has interpreted them to be the deformed and metamorphosed equivalents to Aphebian greywackes and shales of the Labrador Trough. Rb-Sr dates in the same area have indicated a Grenvillian age of metamorphism of this sequence. The paragneiss extends to the northeast into the area of the Red Wine Mountains where it has yielded circa 1660 Ma ages of metamorphism (B. Fryer, personal communication, 1982). At present it is uncertain whether the paragneisses in the Ossokomanuan area were formed by Grenvillian, Paleohelikian or Hudsonian events. In all probability they are polyorogenic.

Unit 2: Orthogneiss and Foliated Granitoid Rocks

This unit comprises a variety of predominantly granodioritic to quartz mozonitic lithologies that are intrusive into unit 1.

Migmatitic granodiorite and tonalite (unit 2a). In the east, northeastern and central parts of the map area grey, fine- to medium-grained, hornblende-biotite granodiorite and tonalite occur. Homogeneous, and randomly to lit-par-lit migmatized types are present.

Central megacrystic granodiorite (unit 2b). This unit consists mostly of homogeneous, foliated, megacrystic granodiorite with euhedral to rounded K-feldspar megacrysts up to 5 cm long. The unit is rarely gneissic. Relict megacryst cores are grey to purple, contain primary biotite and plagioclase inclusions, and have been partly polygonized during posttectonic recrystallization. The megacrysts are thought to be of primary origin. Partial melting was rare but, where present, apparently did not affect the megacrysts, despite experimental predictions to the contrary (Wyllie et al., 1976).

The unit also contains a finer megacrystic facies characterized by 0.5-1 cm diameter, ragged, microline crystals that appear to represent porphyroblasts developed in originally equigranular granodiorite. Both facies contain nonmegacrystic rocks with which there are no sharp contacts.

Dykes of coarse augen granodiorite are intrusive into paragneiss of unit 1, and the megacrystic granodiorite also contains inclusions of paragneiss.

Megacrystic quartz monzonite (unit 2c). This unit occurs in the southwestern part of the area and is composed of strongly foliated, megacrystic, quartz monzonite. The medium grained groundmass contains biotite and probably orthopyroxene. One body contains xenoliths of folded migmatitic paragneiss.

[1] Distribution of fabric elements in (3D) layers.

Sphene-rich, megacrystic quartz monzonite and gneissic equivalents (unit 2d). Foliated, megacrystic, biotite-hornblende-quartz monzonite is characteristic of the area north of Baikie Lake. Relict K-feldspar is common and sphene is an abundant accessory mineral. Migmatization was confined to a few discordant veins commonly following the locus of small shear zones. To the east, west and south the granitoid rocks become progressively deformed and recrystallized. K-feldspar is replaced by elliptical aggregates of microcline, and evidence of late migmatization, consisting of discordant quartzofeldspathic veins with large poikilitic hornblende grains, is more abundant. Further deformation induced attenuation of the feldspathic aggregates, imparting a banded appearance to the rock that is enhanced by concordant veins of anatectic granite and aplite. Discordant, migmatitic veins with poikilitic hornblende are also present but sphene was not observed. Diorite inclusions are rare.

Pink, granite banded orthogneiss (unit 2e). A strongly banded orthogneiss consisting of a pale grey, granodioritic paleosome and pink, granitic, migmatitic layering outcrops between Baikie Lake and Ossokmanuan Lake. The granitic layers range from centimetre-wide veins to metre-thick dykes and dominate the lithology. Both granite and granodiorite contain hornblende, biotite and epidote; the epidote appears stable and is located at plagioclase-hornblende grain boundaries.

Pink granite (unit 2f). Pink, biotite-bearing aplite and fine grained granite occur at the southern end of Ossokmanuan Lake. These contain a vague migmatite banding defined by slightly coarser aplitic phases.

Correlation of unit 2. The rocks around Baikie Lake (unit 2d) are the southerly continuation of the granitoid gneisses (unit 9) of Wardle and Britton (1981). The remainder of unit 2 is similar to other members (units 6, 7 and 8) of the granitoid plutonic lithologies of Wardle and Britton (1981) which pass north into weakly deformed plutonic rocks apparently intruded circa 1650-1700 Ma (C. Brooks, personal communication, 1982). Unit 2 as a whole also has features indicating possible correlations with the North Pole Brook Intrusive Suite (Thomas and Hibbs, 1980) in the Red Wine Mountains to the northeast, and the Michikamau plutonic suite (Nunn, 1981; Nunn and Noel, 1982) around Michikamau Lake to the north. The North Pole Brook Intrusive Suite has yielded Rb-Sr ages of around 1650 Ma (B. Fryer, personal communication, 1982). We draw attention to the textural and lithological similarities between this suite and unit 2, and tentatively suggest an equivalent age for unit 2.

Unit 3: Shabogamo Intrusive Suite

The gabbroic rocks in the map area are divisible into three main types: subophitic to intergranular textured gabbro and leucogabbro, layered varieties, and equigranular leucogabbro. In most parts of the area gabbro has generally been emplaced into low structural levels.

Intergranular textured gabbro (unit 3a). The intergranular textures vary from fine- to coarse-grained and consist of randomly orientated plagioclase laths, with a groundmass of pyroxene and magnetite. Olivine was recorded by Wardle (1982). Pegmatitic patches with intergranular textures are common and grade into the normal gabbro. The pegmatites generally preserve primary gabbro mineralogy as purple plagioclase laths, up to 20 cm long, intergrown with shiny, grey pyroxene (?bronzite). In the finer grained rocks the primary mineralogy is preserved only in eastern parts of map area H/7; elsewhere corona textures or alteration to an amphibolite facies mineralogy prevail. Several mineralogical variations occur in the coronas:

i) Amorphous brown core (altered olivine?) ± pale fibrous zone (orthopyroxene or termolite?) + deep green fibrous zone of actinolite + garnet + plagioclase.

ii) Matt black, uncleaved, mafic mineral (uralite?) ± garnet + white, granular plagioclase ± relict, green, saussuritized plagioclase cores.

iii) ± relict orthopyroxene + green hornblende and/or biotite + garnet + plagioclase.

The first two types may have developed in response either to igneous re-equilibration or to metamorphism. They occur only in areas where primary textures are well preserved. The third type is a metamorphic corona.

Layered gabbros (unit 3b). Layered gabbro is not as abundant as the unlayered unit. The layering results from variations in mineral proportions and grain size heterogeneities. Layered gabbro is exposed in the body west of Baikie Lake where composition ranges from gabbro to leucogabbro with minor anorthositic layers. Mineralogical grading, inclusions of underlying layers, and igneous lamination are present and primary mineralogy and corona types (i) and (ii) are common. Compositional layering also occurs in gabbro bodies in the southeast of area H/7 and farther south in the area of the power line. Most of these gabbros are strongly deformed and metamorphosed and pyroxene is pseudomorphed by hornblende or is left as relicts rimmed by biotite. Garnet occurs as coronas or is disseminated within recrystallized plagioclase.

Equigranular leucogabbro (unit 3c). Almost all of unit 3 in the southwestern area is equigranular leucogabbro. The unit is dominated by fine grained, two-pyroxene leucogabbro with minor hornblende; the main ferromagnesian minerals being orthopyroxene and diopside. Clinopyroxene or hornblende occur as rare coronas round orthopyroxene, and garnet is a rare accessory. The leucogabbros are mostly homogeneous, lacking any layering, contain coarser grained sweats, and are weakly foliated with a polygonal texture. They are cut by finer grained dykes of similar composition and also contain a few coarse grained, gabbroic to ultramafic patches net-veined by anorthositic material. The leucogabbro may be unrelated to the intergranular and layered gabbros.

Two-pyroxene metagabbro (unit 3d). Two bodies containing metamorphic mineral assemblages of plagioclase + orthopyroxene ± diopside ± hornblende ± biotite occur in the south and east of the area. The surrounding paragneiss, orthogneiss and gabbro, however, contain amphibolite facies assemblages.

Contacts between unit 3 and other units have not been observed and the relative ages of units 2 and 3 are not known. The intergranular textured gabbro west of Baikie Lake is continuous to the west with gabbro of the Shabogamo Intrusive Suite (Rivers, 1982). Textural comparison with this suite (cf. Fahrig, 1967; Rivers, 1980; Wardle and Britton, 1981) also indicates that a preliminary correlation can be made with the remainder of unit 3. The Shabogamo Intrusive Suite has been dated at .1375 ± 60 Ma (Brooks et al., 1981) to the northwest of this area.

Unit 4: Alkali-Feldspar Granite

This unit, a white weathering, very coarse grained, alkali-feldspar granite, occurs in the southeast of the area. The granite contains abundant muscovite, magnetite and

Table 51.1

Summary of chronology incorporating structural and metamorphic events

UNIT	EVENTS	FOLDING, FAULTING	FABRICS	MIGMATIZATION	METAMORPHIC GRADE
1	*Deposition*				
	Basic dykes				
	HD_1		*HS_1, Location fabric in (1a, c)*	*HM_1, major*	*Au +*
	HD_2	*HF_2, rare insoclines in (1a)*			*A +*
	Basic dykes				
2	*Intrusion*	*relative ages unknown*			
3	*Intrusion*				
	GD_1	*GF_1, isocline(s?) in (3b)*	*GS_1, Location fabric weak in (2b, f) variable in (2a, d), strong in (2e)*	*GM_1, possible range in (1)*	*A +*
	GD_2 - early	*GF_2, tight to isoclinal in (1, 2), thin shear zones in (3)*	*GS_2, major, mineral and shape fabrics in (1, 2, 3)*	*GM_2, minor + late to post -tectonic sweats*	*Au north* *G south*
	- late	*Thrusting, possible range or regeneration*	*Mylonite*		*Au*
	GD_3, possible range	*Thin shear zones in (2)*	*GS_3, diorite in (2d) only*	*GM_3, possible range in shear zones only*	*A*
	Basic dykes?				
	GD_4	*GF_4, open to tight, regional map scale*			
4	*Intrusion*			*2-mica and muscovite-bearing granite dykes*	*A*
	D	*Faulting*			*G;*

Numbers in parentheses refer to legend and text.
A, amphibolite; Au, upper amphibolite facies; G, granulite facies; Gs, greenschist facies; + denotes "or higher"; north and south are regional designations referring to the two metamorphic terrains (see text).

minor biotite and a small xenolith of folded paragneiss restite. Although this rock could be a part of unit 2, we suggest, because of primary igneous textures and a lack of deformation, that it could be the end product of Grenvillian migmatization: an "S-type" granite.

Related late and posttectonic granite dykes and milky quartz veins are present throughout the area but are not represented on the map. The dykes are commonly graphic and muscovite ± biotite-bearing. Both the dykes and the quartz veins have alteration halos in the adjacent paragneiss in which muscovite has partly or wholly replaced restite foliae for distances of up to 2.5 m from the contacts. Unit 4 dykes intrude all other units.

Structure and Metamorphism

Table 51.1 summarizes the structural amd metamorphic history of the area. Pre-Grenvillian deformation is assumed to be Hudsonian (HD) but conceivably could be early Paleohelikian in age. All units were strongly deformed and metamorphosed in the Grenville Orogeny (GD).

The earliest structure recognized in the area is the migmatitic layering that is pervasive throughout most of unit 1. It occurs as layers of granitic melt in the paragneiss (unit 1a) and as a quartz segregation layering in the basic gneiss (unit 1c). The layering formed during the first deformation HD_1 which occurred at upper amphibolite or higher metamorphic grade. Relict HD_1 prismatic sillimanite forms dense lineated mats parallel to the restite foliae.

Rare examples of isoclinal folds of the layering formed during HD_2. They predate the intrusion of basic dykes and K-feldspar megacrystic granitoid rocks in the southwest.

The deformation sequence is divided by the emplacement of units 2 and 3 which are taken to represent markers between Grenvillian and older deformation.

GD_1 is represented by isoclinal folding of layered gabbro in unit 3 and by variable degrees of migmatization in unit 2. Crosscutting migmatitic veins in unit 1 were probably developed at this time.

The metamorphic facies attained during the HD_2 and GD_1 events are unknown because there are no surviving index minerals that may be confidently assigned to either of these events. However, two metabasic bodies (unit 3d) in the south and east of the map area contain orthopyroxene + diopside assemblages indicating that metamorphism during GD_1 may have peaked in the lower granulite facies.

GD_2 structures represent a major structural reworking throughout the area. Concordant and crosscutting migmatitic veins of HD_1 and GD_1 generation in both the paragneiss and the orthogneiss units were tightly to isoclinally folded during GD_2 with the development of a strong axial planar mineral foliation in most lithologies. Syntectonic axial plane-parallel migmatization was minor but this fabric was greatly enhanced by the intense transposition of the pre-existing location fabrics. Fold mullions, augen gneisses and a strong shape and mineral rodding indicate an extensional strain regime. Lineations generally plunge south-southeast at moderate angles.

The gabbroic rocks of units 3a and 3b responded inhomogeneously to the GD_2 deformation. The foliation of these units is composed of strongly deformed shape aggregates of plagioclase, hornblende and garnet and cuts across GD_1 folds. Foliated gabbro of unit 3a contains augen of relatively undeformed gabbro. Some augen and the large body west of Baikie Lake are deformed only in discrete, narrow shear zones which contain an amphibolite facies mineralogy.

The southwestern metamorphic terrane is characterized by a more intense development of the structures during GD_2 compared to the remainder of the map area. The migmatitic layering has a consistent approximately north-trending strike and steep dip, and the fabric in the paragneiss is commonly porphyroclastic or submylonitic in texture. The lineation pitches moderately to steeply to the south on the foliation. GD_2 deformation in unit 3c was more homogeneous and resulted in a penetrative granulite facies mineral fabric.

The GD_2 deformation was accompanied by a pervasive mineral recrystallization. This occurred at granulite facies grade in the southwestern and southeastern parts of the area, where it represented peak metamorphism, and is characterized by mineral assemblages containing sillimanite ± biotite in the paragneiss, and orthopyroxene ± diopside ± hornblende ± biotite ± garnet in the orthogneiss (units 2 and 3). Throughout the remainder of the area upper amphibolite facies conditions prevailed and characteristic index mineral assemblages consist of combinations of sillimanite, biotite, hornblende and garnet. Sillimanite-bearing paragneiss developed fine grained biotite selvages at restite and melt contacts in both granulite and amphibolite facies terranes.

The eastern boundary between the granulite facies uplands and the enveloping amphibolite facies in map area H/2 is a mylonite zone dipping moderately to the west. The remainder of the contact is unexposed. The mylonite is glassy and structurally conformable with the GD_2 foliation and lineation on either side of the zone. Within the granulite facies terrane the foliation is disposed into a map scale synform indicating that the mylonite originated as a deep level ductile thrust along which granulite facies supracrustals were translated northwards over their amphibolite facies equivalents. Although the structural conformity of the mylonite with the GD_2 structures indicates a coeval relationship between the two, the thrusting must postdate the peak metamorphic conditions associated with the formation of the structures (Table 51.1). The mylonite zone is parallel to other high strain zones in the area, both to the east and west. These zones are usually porphyroclastic and less glassy than the example described above.

Post-GD_2 static recrystallization has partly to completely annealed pre-existing fabrics. Coarse grained random needles of sillimanite sporadically overprint the restite foliae in paragneiss of the southern part of the area. Hydration accompanied the recrystallization in the northern areas and the paragneiss is characterized by posttectonic garnet and mimetic textured sillimanite and biotite.

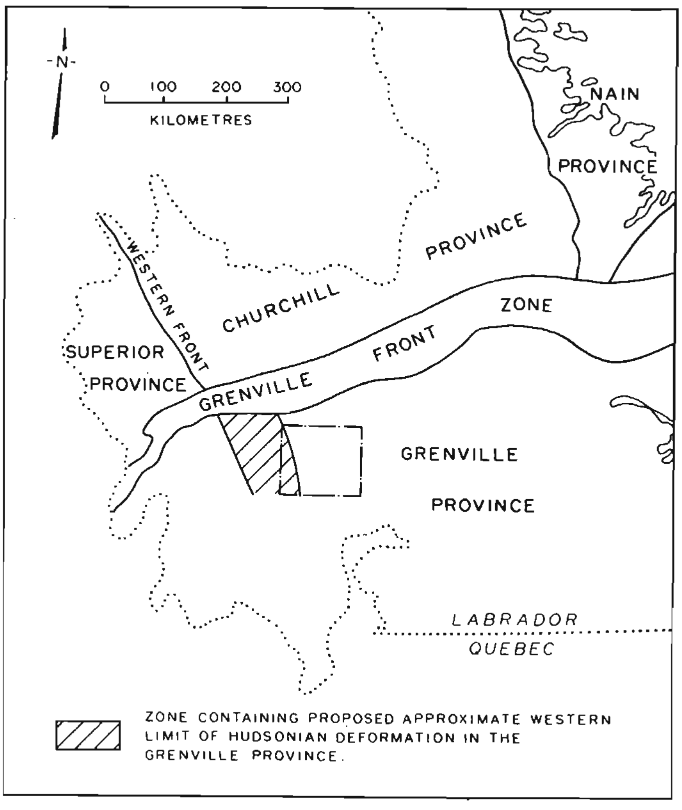

Figure 51.3. *Proposed zone containing the possible extension of the western Hudsonian Front south of the Grenville Front Zone. Province boundaries modified from Stockwell (1961) and Smyth and Greene (1976); Grenville Front Zone modified from Gower et al. (1980) and other work of the Newfoundland Department of Mines and Energy.*

The GD_2 foliation is deflected in shear zones (GD_3) in some of the unit 2 orthogneiss. The shear zones are variable in orientation and may form the locus of late migmatite veins. The veins contain equant quartz and feldspar and coarse grained, poikilitic hornblende.

The map pattern is controlled by regional scale folds (GD_4) that are generally moderate to open. Fold axes fan from north-trending in the southwest to northwest-trending in the northeast. A weak fracture cleavage may be developed in the quartzofeldspathic minerals in GD_4 fold hinges. GD_4 and GD_2 are commonly coaxial but there is no known new mineral growth associated with the later deformation. A retrogressive appearance to some foliation surfaces in the Atikonak River area indicates continuing motion in the thrust zones or reactivation during GD_4.

Muscovite occurs throughout the amphibolite facies area in localized patches or associated with faults and unit 4 pegmatite dykes and quartz veins. The muscovite is always a replacement mineral growing randomly both within and across the restite foliae and in the adjacent melts, and appears to be the result of late retrogression.

Many brittle structures transect the area and postdate GD_4. Two fault systems, in particular, trending approximately 020° and 100°-200°, control the gorge system of the Churchill River (A. Thomas, personal communication, 1982) and its tributaries in the north of the map area. The 100°-120° set has a transcurrent, dominantly sinistral, sense of displacement and appears to be the younger of the two.

Discussion

The metamorphic fabrics in the Helikian granitoid and gabbroic rocks of units 2 and 3 respectively, clearly indicate that the area has been thoroughly affected by high grade, Grenvillian, dynamothermal metamorphism. The strong similarity of fabrics in these units to those in the paragneiss would initially suggest that both formed during the same event. However, several key outcrops suggest that the primary layering developed at different times. Megacrystic granitoid rocks of unit 2, which elsewhere have been migmatized and subsequently further deformed, include paragneiss xenoliths with a melt layering that was clearly folded prior to incorporation. Similar fe-tures were described by Wardle (1982) for granitoid rocks south of the area. Some of the paragneiss has, therefore, been deformed by early events prior to the emplacement of orthogneiss and gabbro and is polyorogenic in origin.

Assuming the correlation of unit 2 with the North Pole Brook Intrusive Suite (ca. 1650 Ma) and of unit 3 with the Shabogomo Intrusive Suite (ca. 1375 Ma) the tectonic events recorded in the paragneiss inclusions represent the Hudsonian or an early Paleohelikian orogeny. The Paleohelikian has not yet been shown to be a time of gneiss-forming deformation in central Labrador and the Hudsonian Orogeny is thought to be a more likely cause of early deformation in the paragneiss. The structural boundary between the Churchill and Superior provinces outside of the Grenville Province (Fig. 51.3) is located to the northwest of the map area. The continuation of this boundary, the Hudsonian Front, although probably offset to the east by structural telescoping in the Grenville Front Zone, must still pass to the west of most of the map area (Fig. 51.3).

A similar polyorogenic sequence has been documented affecting gneisses in the Red Wine Mountains (Thomas, Jackson and Finn, 1981) and is suspected in the granulite facies terrane contiguous with the southeastern part of the map area (A. Thomas, personal communication, 1982).

However, a detailed isotopic dating study is needed to confirm the presence of Hudsonian tectonites within this area of the Grenville Province.

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References

Brooks, G., Wardle, R.J., and Rivers, T.
1981: Geology and geochronology of Helikian magmatism, western Labrador; Canadian Journal of Earth Sciences, v. 18, p. 1211-1277.

Eade, K.E.
1952: Preliminary map: Unknown River (Ossokmanuan Lake east half), Labrador, Newfoundland; Geological Survey of Canada, Paper 52-9.

Fahrig, W.F.
1967: Shabogamo Lake map-area, Newfoundland-Labrador and Quebec; Geological Survey of Canada, Memoir 354, 23 p.

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, v. 17, p. 784-788.

Greene, B.A.
1972: Geological map of Labrador, 1:1,000,000; Newfoundland Department of Mines, Agriculture and Resources, Mineral Resources Division.

1974: An outline of the geology of Labrador; Newfoundland Department of Mines and Energy, Mineral Development Division, Information Circular no. 15, 64 p.

Nunn, G.A.G.
1981: Regional geology of the Michikamau Lake map area, central Labrador; in Current Research, Newfoundland Department of Mines and Energy, Report 81-1, p. 138-148.

Nunn, G.A.G. and Noel, N.
1982: Regional geology east of Michikamau Lake, central Labrador; in Current Research, Newfoundland Department of Mines and Energy, Report 82-1, p. 149-167.

Rivers, T.
1980: Revised stratigraphic nomenclature for Aphebian and other rock units, southern Labrador Trough, Grenville Province; Canadian Journal of Earth Sciences, v. 17, p. 668-670.

1982: Preliminary report on the geology of the Gabbro Lake and McKay River map areas (23H/11 and 23H/12), Labrador; Newfoundland Department of Mines and Energy, Report 82-2, 27 p.

Smyth, W.R. and Greene, B.A.
1976: Isotopic age map of Labrador; Newfoundland Department of Mines and Energy, Mineral Development Division, Map 764.

Stockwell, C.H.
1961: Structural provinces, orogenies, and time classification of rocks of the Canadian Precambrian Shield; in Geological Survey of Canada, Paper 61-17, p. 108-118.

Thomas, A. and Hibbs, D.
1980: Geology of the southwestern margin of the Central Mineral Belt; in Current Research, Newfoundland Department of Mines and Energy, Report 80-1, p. 166-181.

Thomas, A., Jackson, V., and Finn, G.
1981: Geology of the Red Wine Mountains and surrounding area, central Labrador; in Current Research, Newfoundland Department of Mines and Energy, Report 81-1, p. 111-120.

Wardle, R.J.
1982: Geology of the Churchill Falls Region; in Current Research, Newfoundland Department of Mines and Energy, Report 82-1, p. 131-148.

Wardle, R.J. and Britton, J.M.
1981: The geology of the Churchill Falls area, Labrador; in Current Research, Newfoundland Department of Mines and Energy, Report 81-1, p. 130-137.

Wyllie, P.J., Huang, W.H., Stern, C.R., and Maaloe, S.
1976: Granitic magmas: possible and impossible sources, water contents and crystallization sequences; Canadian Journal of Earth Sciences, v. 13, p. 1007-1019.