SUMMARY OF FIELD WORK IN THE NORTHERN LONG RANGE MOUNTAINS, WESTERN NEWFOUNDLAND

by

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Abstract

In preparation for mapping the Precambrian terrane of the northern Long Range Mountains of Newfoundland at 1:100,000 scale, two strips were mapped in 1983, along the western side of White Bay and along the Upper Humber River. The report presents a review of the tectonic nature of the terrane, followed by generalized geological maps and descriptions of the major rock units of the two mapped strips. An Helikian or older quartzofeldspathic basement gneiss complex, at least part of which is metasedimentary, was intruded by a gabbro-anorthosite massif and by megacrystic granitic rocks of probable Neohelikian age. Metamorphic grade is generally in the amphibolite facies, with granulite grade rocks occurring locally; a retrograde greenschist event affected the entire eastern portion of the terrane.

Introduction

The Precambrian terrane of the northern Long Range Mountains is a high grade granite-gneiss complex that is generally assumed to be an inlier of the Grenville Province in the miogeoclinal belt of the Appalachian Orogen. It occupies nearly 8500 km^2 of the Great Northern Peninsula of Newfoundland (Figure 1). Of this area, only about 2000 km^2 have been mapped systematically, at 1:125,000 scale (Bostock, 1983); little is known about the remaining portion which extends over parts of fourteen 1:50,000 scale NTS map areas. Mapping of the remaining area at 1:100,000 scale is to be initiated in the near future. In preparation, a reconnaissance project was carried out in the summer of 1983.

Tectonic Setting of the Precambrian Terrane

One of the principal aims of future systematic mapping will be to compare the rock types and tectonic framework of the region with those of the Grenville Province in adjacent southern Labrador. Little is known about the rocks underlying the Strait of Belle Isle, which separates insular Newfoundland from Labrador. If the Long Range Mountains constitute an inlier, many similarities to the mainland Grenvillian rocks can be expected. However, if strong contrasts are found or if the similarities are weak, the autochthonous nature of the terrane will be in doubt; the 'inlier' may have been displaced from the more interior parts of the Appalachian Orogen during Paleozoic tectonism.

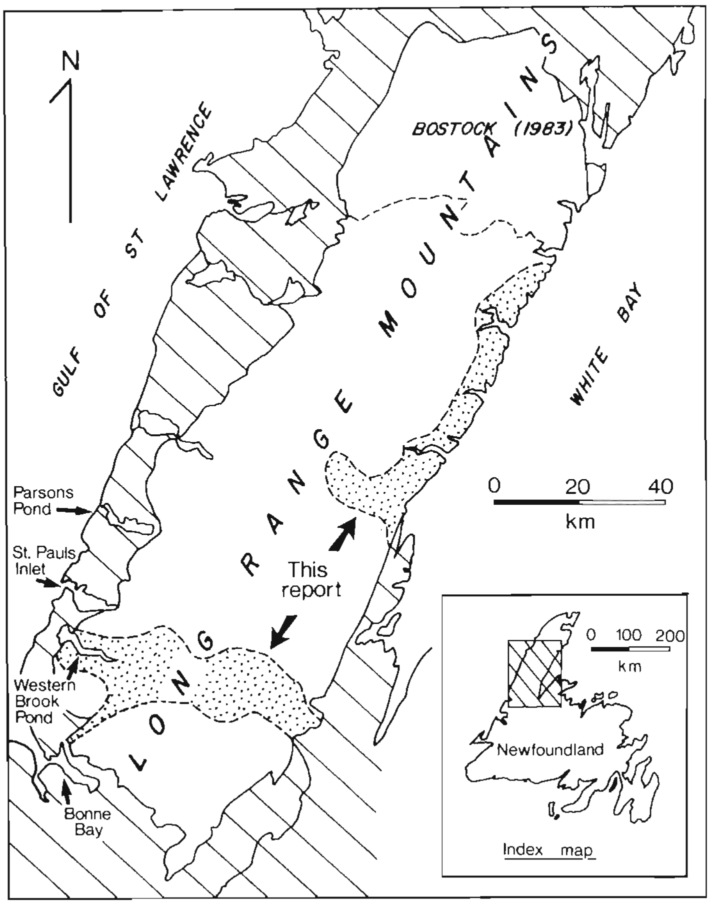

Figure 1: *Location of the Precambrian terrane of the northern Long Range Mountains. Paleozoic rocks are shown by hachures. Bostock's (1983) map area and the two strips mapped for the present study (dot pattern) are outlined.*

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The hypothesis of an overthrust Long Range Mountains terrane was proposed in several early reports of field work at the periphery of the Precambrian rocks. It is also suggested by more recent geophysical observations.

Schuchert and Dunbar (1934) reported that the Precambrian gneiss was thrust over the Paleozoic rocks on the shore of Western Brook Pond. Johnson (1941a,b) concluded that a major east dipping thrust underlies the entire western boundary of the terrane, carrying it over the Paleozoic platformal assemblage to the west. He showed the apparent dip of this fault to be approximately 60° to the east in two cross-sections, and reported the fault to be "almost flat" in an exposure on St. Pauls Inlet. Oxley (1953) also interpreted the contact as a thrust and reported a dip of 34° to the southeast for the fault near Parsons Pond. Similarly, Nelson (1955) suggested the presence of a high angle thrust fault at the boundary. It appears that none of the outcrops described by these authors has been critically re-examined.

The observation that Paleozoic cover rocks in several localities southwest of the margin of the terrane (in the Bonne Bay - Bonne Bay Big Pond area) contain at least three sets of folds (H. Williams, personal communication, 1983) whereas the Precambrian rocks display no equivalent strain, suggests the presence of a decollement at or near the unconformity surface, and differing structural histories for rocks on either side of the contact. This implies at least a parautochthonous character for some of the cover rocks, and suggests the possibility of basement reworking.

On the basis of a paleomagnetic comparison of rocks in western Newfoundland and mainland eastern Canada, Black (1964) concluded that Newfoundland rotated 30° anticlockwise away from Labrador in the Middle to Late Devonian. Although Deutsch and Rao (1977), together with other workers, considered Black's data inconclusive, new measurements led them to conclude that a rotation of 5 to 10° since the Ordovician is possible. Pullaiah et al. (1979), from a reconnaissance study of the Late Hadrynian Long Range dikes, observed that the remanent magnetization of these rocks contains a steeply inclined component that is misaligned with published late Precambrian directions for both Newfoundland and mainland North America; they attributed this discrepancy to a Devonian overprint. However, other interpretations (i.e. terrane displacement) cannot be ruled out until further testing.

A gravity gradient trending diagonally across the area (Haworth et al., 1980) suggests that deep crustal structure is not reflected in the surface distribution of rock types and that the underlying crust may not be entirely sialic. A well defined positive Bouguer gravity anomaly is centered on the southeast portion of the terrane.

To a large extent, the configuration of east dipping faults beneath the Precambrian rocks can only be determined through deep crustal geophysical measurements similar to those of Cook et al. (1979) in the southern Appalachians. Such a study is being considered as part of a Lithoprobe transect through eastern Canada.

In summary, the physical continuity of the Precambrian rocks of the Long Range Mountains with those of the adjacent Canadian Shield is widely assumed (e.g. Williams and Hatcher, 1983; Keppie, *in press)*, but it has not yet been established. On the basis of the above evidence, the paleogeography of the entire region appears unclear. Further investigation may prove the 'inlier' to be either truly autochthonous or displaced Grenvillian crust.

Previous Work and Present Investigations

Previous work in the portion of the inlier not covered by Bostock's (1983) study is summarized below.

Murray and Howley (1881, 1918) examined the east coast of the Great Northern Peninsula and reported mainly granitic gneiss intruded by northeast trending greenstone dikes. Foley (1937) and Fritts (1953) made four traverses across the peninsula, along which they observed various gneissic units of inferred metasedimentary origin, foliated and massive granitic rocks and crosscutting diabase dikes. The British Newfoundland Corporation Ltd. made a reconnaissance survey of the entire terrane in 1954, which resulted in a map at the scale of 1 inch to 2 miles (Harrison and Johnston, 1954).

On a reconnaissance map at the scale of 1 inch to 4 miles, Baird (1959) indicated the presence of gabbro, anorthositic gabbro and anorthosite, along with various granitoid and mafic gneiss units in the southern portion of the terrane. Clifford and Baird (1962) produced the first comprehensive map of the terrane, at approximately 1:100,000 scale. Partly on the basis of data assembled from previous workers, their map shows granitic and basic intrusions of three types within older gneiss,

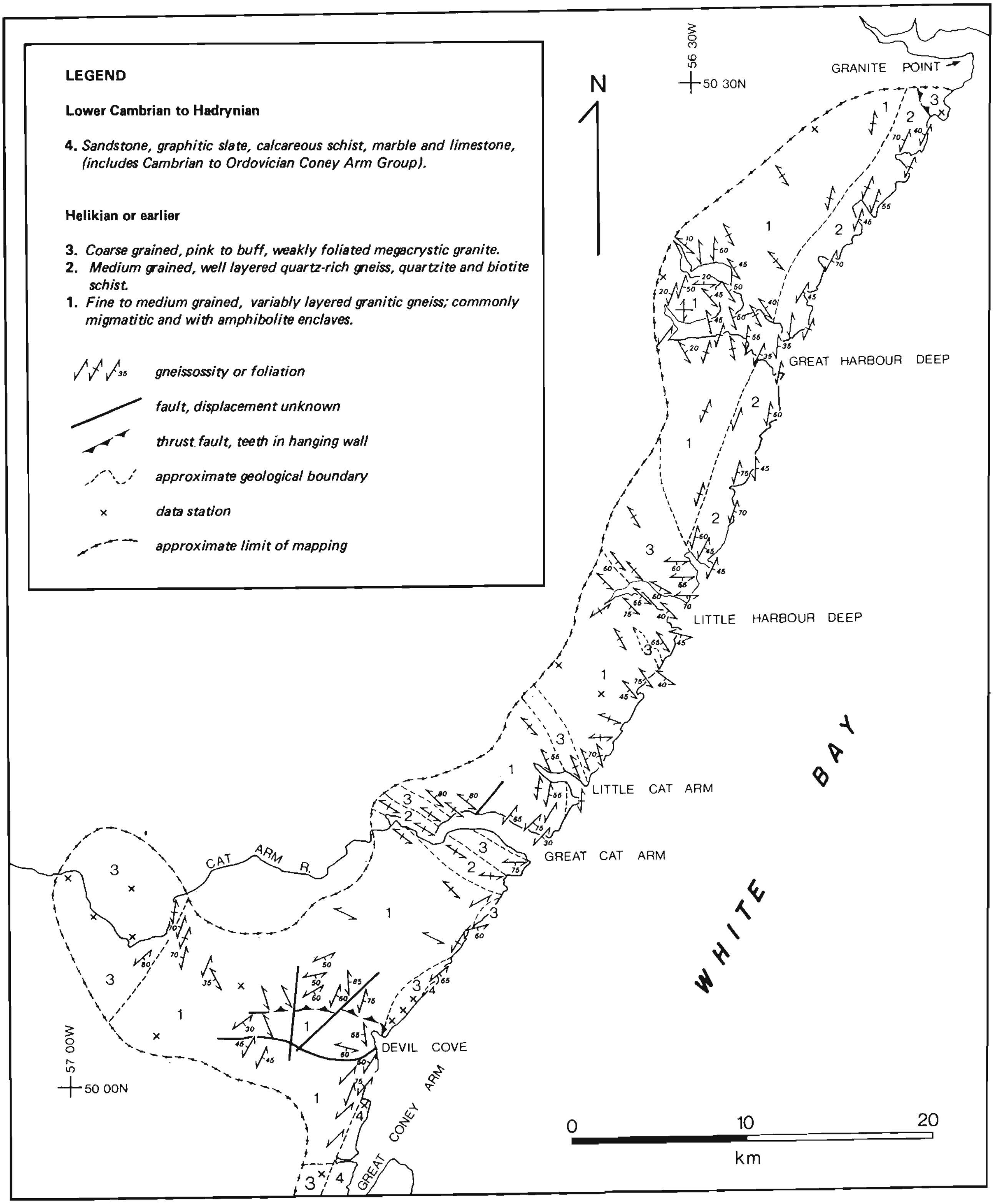


Figure 2: *General geology of part of the east margin of the Precambrian terrane along White Bay. Data stations shown as 'x' are where no structural observations were made.*

and the extent of the Long Range dike swarm; they also reported the occurrence of various schist and gneiss units, and quartzite and metaconglomerate. The regional metamorphic grade was considered to be middle amphibolite. Neale and Nash (1963) mapped the distribution of biotite- and hornblende-rich gneiss and granite units and metagabbro along part of the southeastern margin of the terrane at the scale of 1 inch to 4 miles.

Pringle et al. (1971) reported a Rb/Sr age determination of 1130±90 Ma and a K/Ar age of 840±20 Ma for megacrystic granite in the Hawkes Bay - Portland Creek area. Cumming (1973a,b) and Bostock and Cumming (1973) briefly examined the Precambrian rocks of Gros Morne National Park, and reported the presence of granulite facies gneissic rocks and the existence of a large, apparently domal structure at the head of Western Brook Pond. Stukas and Reynolds (1974) studied several of the Long Range dikes west of Great Harbour Deep, for which they determined an $^{40}Ar/^{39}Ar$ age of 605±10 Ma; they also concluded that the apparent range of K/Ar ages from 756 to 865 Ma for samples from a single dike (reported by Pringle et al. (1971), within the area mapped by Bostock (1983)) results from excess radiogenic argon and should not be interpreted as the dates of emplacement of the dike swarm.

In the light of these studies, the main objectives of 1983 field work were to examine two strips of the terrane, one along the northeast trending coastal section on White Bay, and the other centered on the Upper Humber River between Western Brook Pond and Taylor Brook. A secondary objective was the examination of the area scheduled to be flooded in 1984 as part of the Cat Arm hydroelectric development, and of the bedrock exposed during the construction of dams and tunnels for this project. The results presented below are a contribution to the planned complete study of the inlier, which will aim to answer many of the questions raised by the present regional geological and geophysical data.

Results of 1983 Field Work

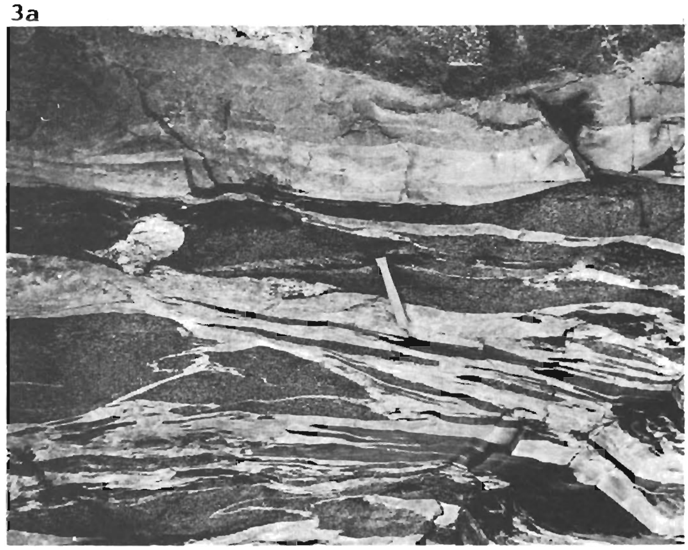
1. <u>Coastal Section</u>

The geology of the Precambrian rocks along White Bay, between Great Coney Arm and Granite Point, is shown in Figure 2. Exposure is excellent along White Bay, and fair to poor inland from the coast.

a. <u>Map units</u>

Unit 1 includes a variety of rock types that are broadly grouped as quartzofeldspathic gneiss. They are pink to gray, heterogeneous, medium to coarse grained, generally well layered but equigranular in places, migmatitic hornblende or biotite granitic gneiss (Figure 3). This gneiss includes abundant layers and lenses of amphibolite, some crosscutting and others conformably interlayered, suggesting more than one protolith. They are interpreted in large part as relict dikes. Similarly, pegmatite and migmatite veins and segregations both follow the gneissosity and truncate it. Thinly laminated layers of quartz-rich gneiss are present in many outcrops within

3a



3b

Figure 3: **(a)** *Granitic gneiss and interlayered amphibolite of Unit 1.* **(b)** *Heterogeneous, tightly folded gneiss of the same unit. Both photographs are from outcrops on the shore of White Bay.*

Unit 1; this gneiss is differentiated as Unit 2 on the map where extensive. It is considered to be of metasedimentary origin. Other layers include pink, megacrystic orthogneiss of granitic to monzonitic composition that is correlated with the rocks of Unit 3. Unit 1 thus contains rocks of differing protoliths, and is likely to have had a prolonged strain history. Pending further subdivision, Unit 1 is correlated with the bulk of the old gneiss complex to the northwest (Bostock, 1983), which is of Helikian or older age.

Unit 2 is exposed in two elongate slices several kilometres long which are interlayered with Unit 1. It is an assemblage of dominantly medium grained, gray to white, finely banded quartz-rich gneiss (in which quartz forms up to 90% of the rock, and feldspars and biotite the remainder), medium grained quartzite, and minor medium to fine grained biotite schist (Figure 4). Other minor rock types such as chlorite schist, fine grained amphibolite and transitional layers are present in a few outcrops. A few gossan areas of 10 to 40 m^2 each were noted in layers of Unit 2 on the coast. Mineralization appears to be mostly disseminated pyrite, and minor chalcopyrite or hematite and magnetite. A metasedimentary origin is inferred for most of the rocks of Unit 2. The unit is correlated with minor rock types (pelitic schist, muscovite chlorite schist, amphibolite and quartz-rich gneiss) differentiated by Bostock (1983) within the basement gneiss to the northwest, for which a Helikian or older age has been established.

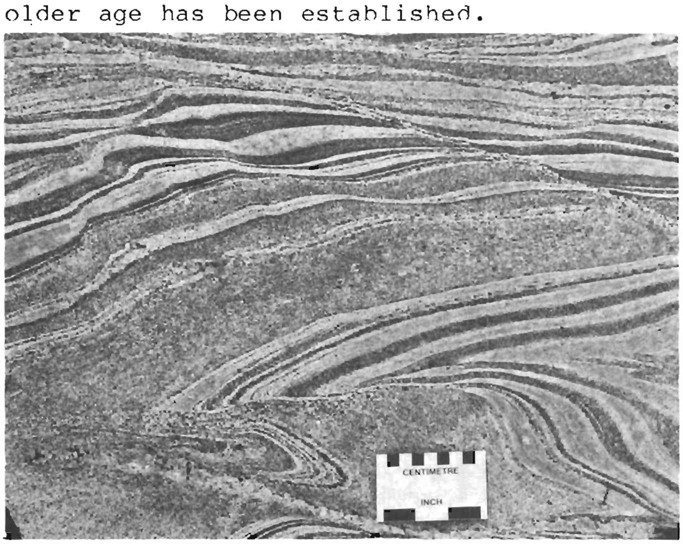


Figure 4: *Finely layered quartzofeldspathic and quartz-rich gneiss of Unit 2, north of Little Harbour Deep.*

Unit 3 comprises a variety of dominantly coarse grained, megacrystic, massive to weakly foliated granitic rocks exposed in several places along the coast and inland (Figure 5). Their relation to Units 1 and 2 appears to be mainly intrusive, although the contact was moderately to strongly modified by later strain and is generally poorly exposed. Where it is exposed, the rocks of Unit 3 crosscut the main gneissic fabric, and have been involved in a subsequent, less intense deformation. To the west of Great Coney Arm, the rock is generally massive, coarse grained and commonly subporphyritic, buff granite with a characteristic dark green,

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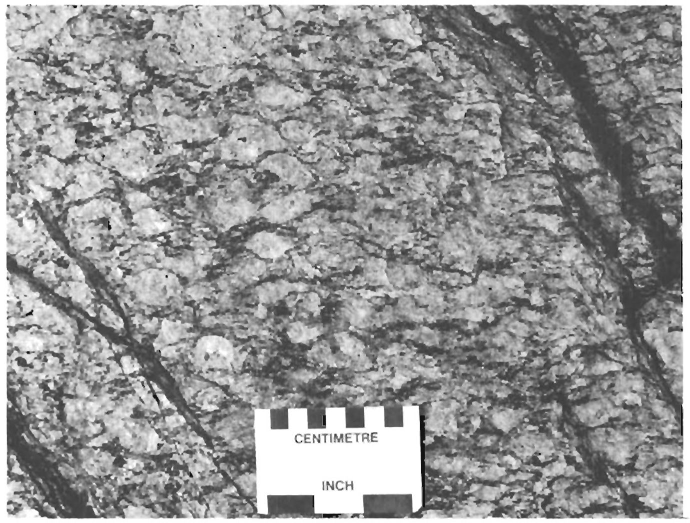

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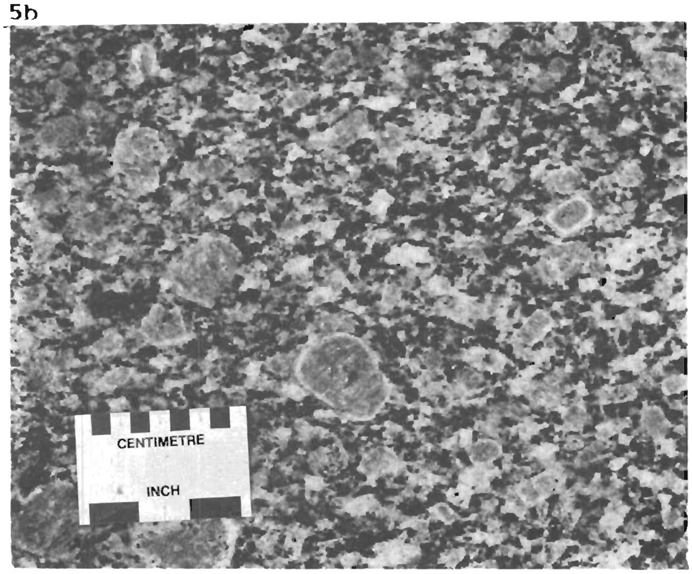

Figure 5: **(a)** *Foliated megacrystic granite of Unit 3 near Little Harbour Deep.* **(b)** *Massive granite of Unit 3 north of Devil Cove.*

relatively fine grained groundmass. The body exposed along the upper Cat Arm River is medium to coarse grained, almost equigranular, pink, leucocratic granite that is well foliated near its contact with the gneiss of Unit 1. Between Devil Cove and Great Harbour Deep, the rocks included in Unit 3 are moderately to strongly foliated, pink, megacrystic (K-feldspar) granite to alkali feldspar granite the protoliths of which may differ in age. The granite near Granite Point is a massive, equigranular, biotite-bearing, leucocratic rock that overlies the gneiss to the west along a shallow dipping mylonite zone (see discussion of structure). The diversity of rock types within Unit 3 suggests that distinct intrusive suites with slightly different compositions are represented. The rocks of Unit 3 are correlated with other post-tectonic but pre-Grenvillian granite bodies exposed in the region to the north (Bostock, 1983; Pringle et al., 1971).

Units 1 to 3 are crosscut by numerous diabase and metadiabase dikes of the Late Hadrynian Long Range swarm, which measure a few centimetres to more than 50 m across strike. These dikes invariably strike east-northeast; dips vary from vertical to steep to the southeast or northwest.

Unit 4 includes east dipping clastic and carbonate strata that lie unconformably on Units 1 to 3. The erosional unconformity is exposed in two localities along the coast, 2 km to the south and 3 km to the north of Devil Cove, and in many places along the access road to the Cat Arm Development site. The basal rock type is a thin layer (1 to 20 m) of blue-quartz pebble conglomerate and sandstone of the Beaver Brook Formation (Smyth and Schillereff, 1982), which has been correlated with the Eocambrian Bradore Formation (Schuchert and Dunbar, 1934) exposed around the northern margin of the Precambrian terrane. The Beaver Brook Formation, and the overlying marble, graphitic phyllite and schist, limestone, quartzite and dolomite strata are included in the Cambrian to Middle Ordovician Coney Arm Group, as redefined by Smyth and Schillereff (1982), which is interpreted as an autochthonous Lower Paleozoic platformal assemblage.

b. Structure

The main fabric of Units 1 to 3 is a well developed gneissosity or foliation that is commonly affected in outcrop by irregular, asymmetric tight folds ranging from a few centimetres to several metres in amplitude. Steep dips of the planar fabric are common; a few large (up to 100 m amplitude) overturned to recumbent isoclinal folds are exposed in Unit 1 on the coast. Dip variations and reversals over short distances along strike are commonly observed.

Shallow north to northeast dipping mylonite zones up to 20 m thick, exposed west of Devil Cove and south of Granite Point, are the locus of ductile thrust faulting, as suggested by minor structures in at least one locality (D. Besaw, personal communication, 1983). On the basis of the little data available, thrusting appears to have been south-southwesterly directed. Because the granite of Unit 3 south of Granite Point is thrust over Unit 2 (this relationship confirms Bostock's (1983) observation of a south dipping fault to the north of Granite Point), the faulting appears to be of Grenvillian age.

Two thrust faults reported by Foley (1937) on the north shore of Great Harbour Deep are small, brittle, east dipping structures of which the sense of displacement is unclear, and that are probably related to Paleozoic faulting farther east.

c. Metamorphism

All rocks in Units 1 to 3 are pervasively recrystallized. A saccharoidal, friable texture is characteristic of many of the quartzofeldspathic rocks. Migmatite segregations are developed in many outcrops of Units 1 and 2. Metamorphic hornblende and biotite are present almost everywhere, but no mineral assemblages diagnostic of a well constrained pressure-temperature field were found. Epidote, chlorite and sericite are present in most outcrops along the coast as retrograde minerals in the gneissic and granitic rocks. The Long Range dikes are locally heavily chloritized; this alteration appears to decrease progressively inland to the west.

On the basis of this evidence, metamorphic grade in the crystalline rocks is in the amphibolite facies, with extensive overprinting in the greenschist facies which may be weaker to the west.

2. Southern Transect

The geology of the area between Western Brook Pond and Taylor Brook is shown in Figure 6. Exposure in the region is generally fair to poor to the east of Gros Morne National Park, and good within the park.

a. Map units

Unit 1 includes heterogeneous, leucocratic, pink to gray, medium to coarse grained biotite or hornblende granitic gneiss (Figure 7). It is commonly well

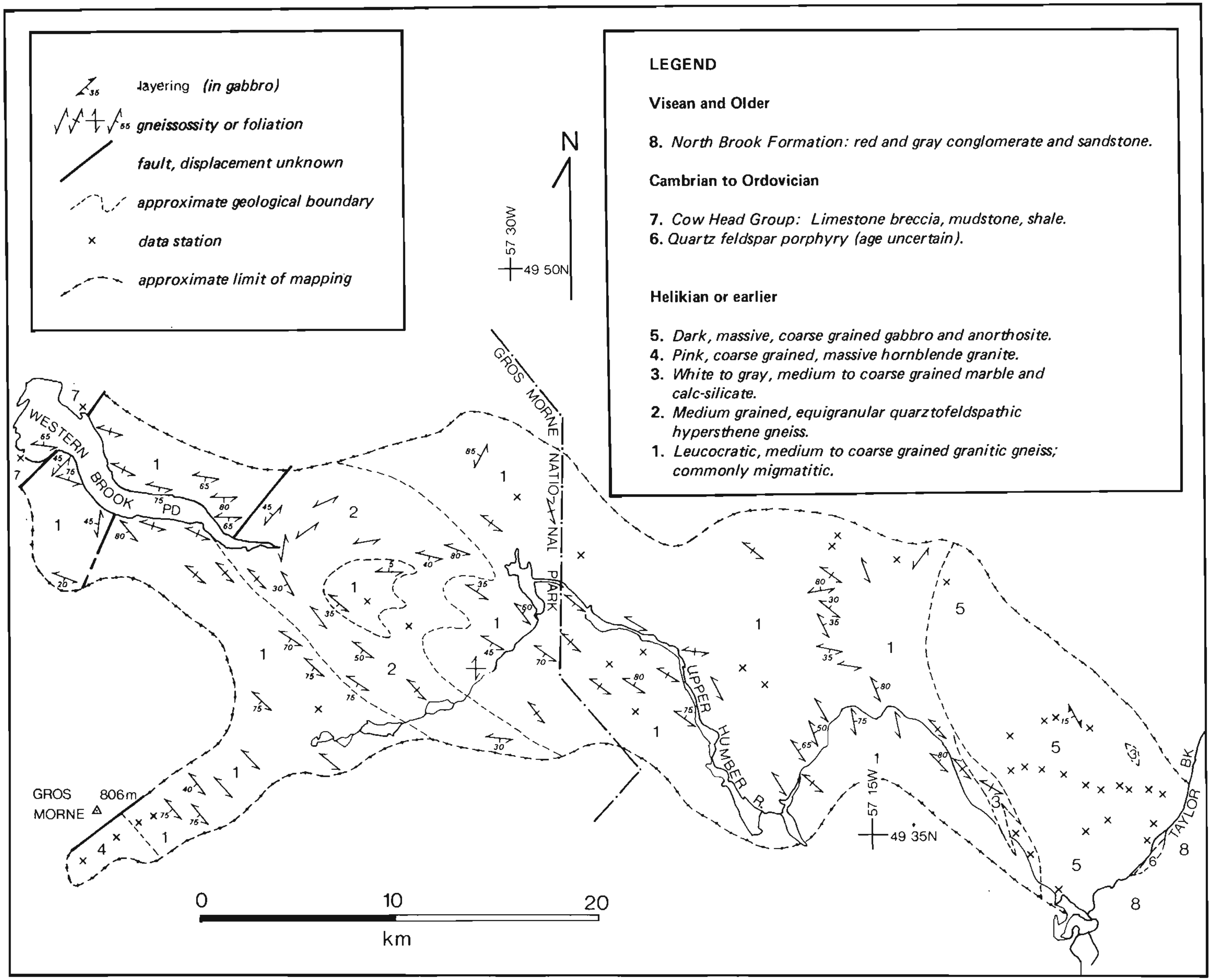

Figure 6. *General geology of the Upper Humber River region between Western Brook Pond and Taylor Brook. Data stations shown as "x" are where no structural observations were made.*

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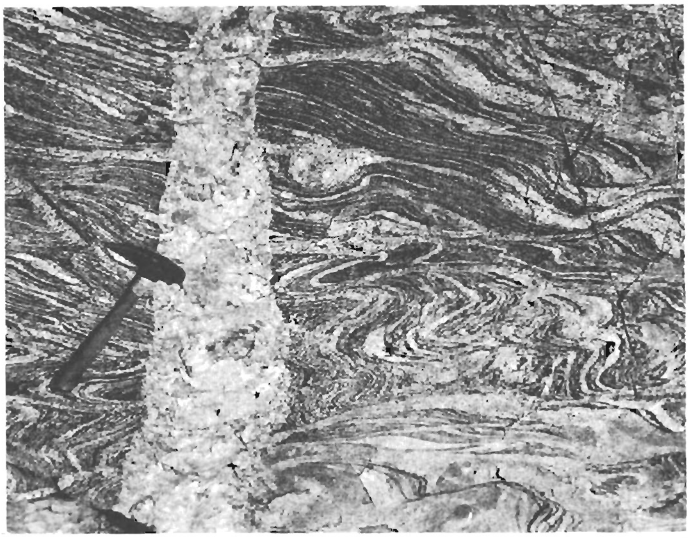

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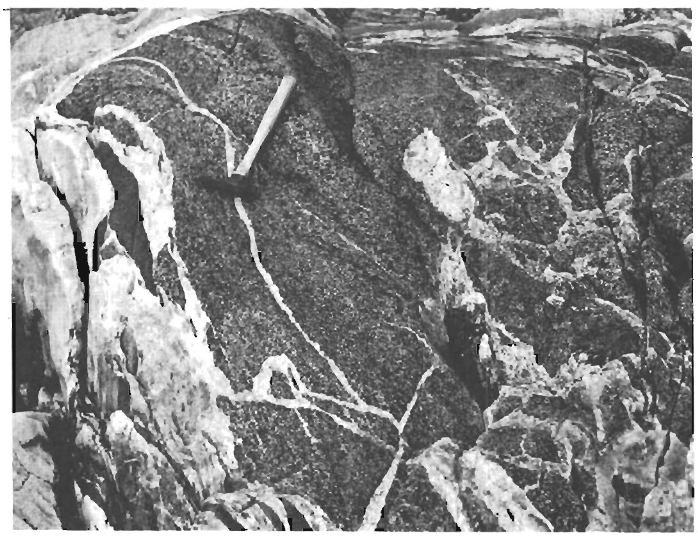

Figure 7: (a) *Well layered, heterogeneous granitic gneiss of Unit 1, near the Upper Humber River.* **(b)** *Amphibolite boudin in the same unit.*

layered and migmatitic, and includes layers and boudins of amphibolite. Although lack of exposure prevents a firm interpretation, the relations between gneiss and amphibolite are probably similar to those observed along White Bay (i.e. both conformable and crosscutting contacts can be seen). Large (up to 6 m across) boulders of distinctive, finely laminated, fine grained sillimanite- and muscovite- rich quartzofeldspathic gneiss occur in the bed of the Upper Humber River near 57°10'W. These boulders appear to be of proximal derivation, and are considered to represent fragments of pelitic layers within Unit 1.

Unit 1 is correlated with the old gneiss exposed along White Bay and in the region mapped by Bostock (1983). The unit is interpreted to be of Helikian or older age and to include rocks of diverse protoliths and various ages.

Unit 2 has most of the characteristics and the overall composition of Unit 1, but is distinguished from it by the presence of medium to coarse hypersthene grains and a waxy, dark olive green color of the feldspars in many outcrops. Its contacts with Unit 1 are mostly gradational, except to the north of Western Brook Pond where a prominent, steep, northeast trending fault separates the hypersthene gneiss from the rocks of Unit 1. As a difference of metamorphic grade appears to be the only difference between Units 1 and 2, their protoliths may have been similar. The granulite facies rocks of Unit 2 do not correlate with rocks elsewhere in the Long Range Mountains, but they may be lithologically similar to leucocratic hypersthene gneiss in adjacent Labrador, described by Bostock (1983). The unit is assumed to be Helikian or older.

Unit 3 comprises marble and calc-silicate rocks exposed in two slices within and at the margins of the gabbro-anorthosite body of Unit 5. The sliver of Unit 3 near the Upper Humber River is mostly white to pale gray, coarsely crystalline, in places graphitic marble with some gray, impure, quartz-rich layers. In at least two outcrops near the contact with the gabbro, the marble grades into a brown and green (diopside-bearing?) fine grained rock a few metres thick. The small sliver of Unit 3 within Unit 5 is a mottled gray and brown, fine grained, tremolite-rich(?) calc-silicate(?) rock exposed on an isolated knoll within the gabbro massif. It is included in Unit 3 on the basis of broad lithological similarity, but its relation to the gabbro and to the marble to the west is unclear. It may be similar to bands of tremolite-chlorite-carbonate rock observed by Bostock (1983) in metagabbro to the north. It may be an intensely altered ultramafic phase, or an inclusion within the anorthositic rocks. The marble to the west appears to be interlayered in the gneiss of Unit 1, and to have been intruded by the gabbro along the Unit 1. Unit 3 is considered to be of Helikian age.

Unit 4 is coarse grained, in places megacrystic, massive to well foliated hornblende granite exposed south of Gros Morne. Its contact with the gneiss to the east is gradational, and is assumed to be originally intrusive. Unit 4 is correlated with rocks of the post-tectonic granitoid suite of Bostock (1983), and with parts of

Unit 3 in the coastal region. It is inferred to be of pre-Grenvillian age.

Unit 5 comprises a range of gabbroic to anorthositic rocks that occur in a large (at least 15 km across) intrusive complex between the Upper Humber River and Taylor Brook. Rock types include coarse grained (up to 5 cm) equigranular, ophitic gabbro and metagabbro, fine to coarse grained dark anorthosite and gabbroic anorthosite, medium grained hornblende diorite, and medium grained buff monzonitic rocks. The rocks are generally massive; primary layering is outlined by mafic minerals in the gabbroic rocks. Dikes of gabbroic material in the surrounding rocks, and inclusions of granitic gneiss within Unit 5 are exposed in several outcrops. Rocks of Unit 5 may correlate broadly with rocks of the anorthosite suite recognized in Labrador by Bostock (1983), but they do not appear to have equivalents within the Long Range Mountains. Unit 5 is interpreted to be of Helikian or older age.

Units 1 to 5 are crosscut by numerous diabase dikes of the Long Range swarm, which vary from 1 to 40 m in width, and appear to be generally better preserved here than along White Bay.

Unit 6 is fresh, dark green or pink, fine grained quartz-feldspar porphyry that occurs in several small, low outcrops east of Taylor Brook, and is seen as a diking phase in Unit 5 to the west of Taylor Brook. The rocks are slightly recrystallized and display little strain. They are inferred to be of Hadrynian or younger age, and to have intruded the Precambrian rocks along the southeast margin of the inlier. They may correlate with parts of the Lower Paleozoic Sops Arm Group mapped on strike to the north by Smyth and Schillereff (1982).

Unit 7 is the allochthonous(?) Cow Head Group of Cambrian to Ordovician age (Schuchert and Dunbar, 1934; Oxley, 1953) which comprises interbedded limestone breccia, lime mudstone, calcarenite and shale on the north and south shores of Western Brook Pond. The contact with the gneiss to the east is not exposed; a brief examination of the Precambrian rocks in several localities along the approximate contact reveals extreme brecciation, iron staining and chloritization of the gneiss, which suggest that the boundary is a fault.

Unit 8 is the North Brook Formation (Hyde, 1982) of Carboniferous (Visean) age, which includes red to gray, pebble to boulder conglomerate and interbedded red to gray sandstone and siltstone, and gray and pink limestone. The unit forms the margin of the Carboniferous Deer Lake Basin and lies unconformably on the Precambrian and Lower Paleozoic rocks to the west.

b. *Structure*

As in most of the rocks of the coastal region, the gneissic rocks of the Western Brook Pond - Taylor Brook area have a well developed main planar fabric that is commonly folded in outcrop by irregular, asymmetric folds resulting from highly ductile strain. Banding in marble is inferred to be transposed original bedding.

The large fold structure outlined by Unit 2 is well exposed at its western extremity and poorly defined in the east. It appears to be a slightly elongate dome; however, discordant dips and the apparent occurrence of lower grade rocks of Unit 1 near its center suggest a more complex structure, such as a nappe of granulite facies rocks infolded with lower grade gneiss into a northwest plunging antiform with its own planar fabric at the center. A detailed structural analysis is needed to test this hypothesis.

The faults exposed north and south of Western Brook Pond are large (longer than 10 km, from aerial photographs) and steep structures that are inferred to have been the locus of at least some dip-slip displacement, as the fault on the north side juxtaposes rocks of clearly different metamorphic grade.

The western contact of the Precambrian rocks was examined only briefly; within the brecciated zone (see above), slickensides in the gneiss appear to be variably oriented. Insufficient data are available to speculate on the nature of the fault that crosses Western Brook Pond.

c. *Metamorphism*

All rocks in Units 1 to 5 are recrystallized, but they do not appear to have the friable, sucrosic texture noted along White Bay. Migmatite bands and lenses are developed extensively in Units 1 and 2. The sillimanite-bearing rocks of Unit 1 (and diopside-bearing? rocks of Unit 3) suggest that Units 1, 3, 4 and 5 underwent metamorphism in the amphibolite facies; rocks of Unit 2 were metamorphosed in the granulite facies before being emplaced next to the amphibolite facies rocks. Only weak retrogression to greenschist facies conditions is apparent in the region, in contrast to the rocks along White Bay. As noted above, the Long Range dikes are increasingly well preserved toward the west. On Western Brook Pond, several spectacular dikes of this swarm are flinty diabase with no sign of alteration (Bostock and Cumming, 1973).

Acknowledgements

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References

Note: Number in square brackets following a reference refers to the files of the Mineral Development Division.

Baird, D.M.
1959: Sandy Lake (West Half), Newfoundland. Geological Survey of Canada, Map 47-1959.

Black, R.F.
1964: Paleomagnetic support of the theory of rotation of the western part of the island of Newfoundland. Nature, Volume 202, pages 945-948.

Bostock, H.H.
1983: Precambrian rocks of the Strait of Belle Isle area. *In* Geology of the Strait of Belle Isle Area, Northwestern Insular Newfoundland, Southern Labrador and Adjacent Quebec. Geological Survey of Canada, Memoir 400, pages 1-73.

Bostock, H.H. and Cumming, L.M.
1973: Some notes on the Precambrian rocks of the Gros Morne National Park, western Newfoundland. *In* Report of Activities, Part B, Geological Survey of Canada, Paper 73-1B, pages 109-119.

Clifford, P.M. and Baird, D.M.
1962: Great Northern Peninsula of Newfoundland, Grenville inlier. Canadian Mining and Metallurgical Bulletin, Volume 65, pages 95-102.

Cook, F.A., Albaugh, D.S., Brown, L.D., Kaufman, S., Oliver, J. and Hatcher, R.D., Jr.
1979: Thin-skinned tectonics in the crystalline southern Appalachians; COCORP seismic-reflection profiling of the Blue Ridge and Piedmont. Geology, Volume 7, pages 563-567.

Cumming, L.M.
1973a: Geology of the proposed Gros Morne National Park, western Newfoundland. *In* Report of Activities, Part A, Geological Survey of Canada, Paper 73-1A, pages 5-7.

1973b: Geology of Gros Morne National Park, western Newfoundland. Geological Survey of Canada, Regional and Economic Geology Division, manuscript (3 volumes).

Deutsch, E.R. and Rao, K.V.
1977: New palaeomagnetic evidence fails to support rotation of western Newfoundland. Nature, Volume 266, pages 314-318.

Foley, F.C.
1937: Geology and mineral deposits of Hawkes Bay - Great Harbour Deep area, northern Newfoundland. Newfoundland Department of Natural Resources, Bulletin 10.

Fritts, C.E.
1953: Geological reconnaissance across the Great Northern Peninsula of Newfoundland. Newfoundland Mineral Resources Division, St. John's, Report 4.

Harrison, W. and Johnston, F.
1954: Geology - Great Northern Peninsula. Unpublished map, British Newfoundland Corporation Ltd.. [Nfld (451)]

Haworth, R.T., Daniels, D.L., Williams, H. and Zietz, I.
1980: Bouguer gravity anomaly map of the Appalachian Orogen. Memorial University of Newfoundland, Map 3.

Hyde, R.S.
1982: Geology of the Carboniferous Deer Lake Basin. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 82-7.

Johnson, H.
1941a: Newfoundland. *In* Possible Future Oil Provinces of Eastern Canada. American Association of Petroleum Geologists, Bulletin, Volume 25, pages 1558-1562.

1941b: Paleozoic lowlands of northwestern Newfoundland. New York Academy of Sciences, Transactions, Series II, Volume 3, pages 141-145.

Keppie, J.D.
in press: The Appalachian Collage. *In* The Caledonide Orogen, Scandinavia and Related Areas. *Edited by* D.G. Gee and B. Sturt. Wyllie and Sons.

Murray, A. and Howley, J.P.
1881: Geological Survey of Newfoundland from 1864 to 1880. London: Edward Stanford, 536 pages.

1918: Reports of Geological Survey of Newfoundland from 1881 to 1909. St. John's: Robinson & Company Ltd. Press, 725 pages.

Neale, E.R.W. and Nash, W.A.
1963: Sandy Lake (East Half), Newfoundland. Geological Survey of Canada, Paper 62-28.

Nelson, S.J.
1955: Geology of Portland Creek - Port Saunders area, west coast. Geological Survey of Newfoundland, Report 7.

Oxley, P.
1953: Geology of the Parsons Pond - St. Pauls area, west coast. Geological Survey of Newfoundland, Report 5.

Pringle, I.R., Miller, J.A. and Warrell, D.M.
1971: Radiometric age determinations from the Long Range Mountains, Newfoundland. Canadian Journal of Earth Sciences, Volume 8, pages 1325-1330.

Pullaiah, G., Rao, K.V., Deutsch, E.R., Murthy, G.S. and Morgan, D.
1979: Paleomagnetism of the Late Precambrian Long Range dikes, Newfoundland: an Acadian remagnetization? Canadian Geophysical Union annual meeting, Fredericton (abstract).

Schuchert, C. and Dunbar, C.O.
1934: Stratigraphy of western Newfoundland. Geological Society of America, Memoir 1, 123 pages.

Smyth, W.R. and Schillereff, H.S.
1982: The pre-Carboniferous geology of southwest White Bay. *In* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 82-1, pages 78-98.

Stukas, V. and Reynolds, P.H.
1974: $^{40}Ar/^{39}Ar$ dating of the Long Range dikes of Newfoundland. Earth and Planetary Science Letters, Volume 22, pages 256-266.

Williams, H. and Hatcher, R.D., Jr.
1983: Appalachian suspect terranes. Geological Society of America, Memoir 158, pages 33-53.

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