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A PRELIMINARY ACCOUNT OF GEOLOGICAL INVESTIGATIONS IN THE CLODE SOUND–GOOSE BAY REGION, BONAVISTA BAY, NEWFOUNDLAND (NTS 2C/5 NW AND 2D/8 NE)

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ABSTRACT

The region bordering the southern reaches of Bonavista Bay lies within the Avalon Zone of the Appalachian Orogen and includes the type areas of the late Precambrian Love Cove, Connecting Point and Musgravetown groups. These rocks record a Precambrian history of early, dominantly subaqueous volcanism and marine siliciclastic sedimentation, inhomogeneous deformation and plutonism, followed by uplift and extension, accompanied by widespread subaerial sedimentation and volcanism. The Precambrian rocks were inhomogeneously deformed again in the Paleozoic, possibly during the formation of the transpressional tectonic boundary between the Avalon and Gander zones. Most of the regional deformation was complete prior to the emplacement of the Terra Nova Granite. The latter is one of several coarse-grained to megacrystic, biotite granites that lie adjacent to or across the Avalon–Gander zone boundary in eastern Newfoundland. Late brittle displacements postdate emplacement of the Terra Nova Granite and are of Devonian and/or younger age. The area has significant exploration potential for gold and rare-earth elements.

INTRODUCTION

Systematic, 1:50 000-scale geological mapping of the Port Blandford (NTS 2D/8) and Sweet Bay (NTS 2C/5) map areas was initiated during the 1992 field season. The most complete and best exposed geological cross-section through this area is around Clode Sound and Goose Bay, and it was here that this survey was concentrated. Investigations were carried out in an area encompassing the northern halves of the NTS map areas 2D/8 E and 2C/5 W (Figure 1), and bounded by north latitudes 48°22'30"(approximate) and 48°30', and by west longitudes 53°45' and 54°15'. A large part of the study area north of Clode Sound lies within the borders of Terra Nova National Park.

This work is a continuation of the northwest Avalon Zone mapping project, which was initiated by the Geological Survey Branch in 1986. This larger undertaking consists of four components:

1) 1:50 000-scale regional mapping of the Avalonian rocks of the western Bonavista Bay region (e.g., O'Brien, 1986, 1987; O'Brien and Blackwood, 1987; O'Brien and Knight, 1988; O'Brien *et al.*, 1991a),

2) investigating the sedimentology and tectonic history of the late Precambrian marine basins in that same region (e.g., Knight and O'Brien, 1988; Dec *et al.*, 1989, 1992),

3) establishing of the absolute chronology of tectonic events within the northwestern Avalon Zone (e.g., O'Brien *et al.*, 1992), and

4) detailed structural mapping of the Avalon–Gander zone boundary within the region (Holdsworth, 1991; O'Brien and Holdsworth, 1992; Holdsworth and O'Brien, *this volume*).

Some of the initial interpretations presented in the following report should be viewed as provisional, and may require revision in light of continued mapping and related work in the same area, scheduled for 1993. Geochemical and petrographic data from the 1992 study are forthcoming but are as yet unavailiable.

PREVIOUS INVESTIGATIONS

In his pioneering account of the geology of Newfoundland, Jukes (1842) recounts observations that he made throughout Bonavista Bay. These include the recognition of 'the slate rock of Bonavista Bay' near the north end of Clode Sound, and in the Sound itself, red sandstones and slates, 'hard, dark-brown slaty gritstone' and 'a red and yellow schistose rock, very rotten and crumbly, and consisting principally of chlorite slate' (Jukes, 1842, page 288). In 1869, Alexander Murray traversed from the mouth of Terra Nova River to Terra Nova Lake, onward to Pitts Pond and thence to Clode Sound. He noted the intrusive relationship of granite near Terra Nova Lake and 'a great development of red sandstones and conglomerates' along the south shore of Clode Sound (Murray and Howley, 1881, p.196). He correlated the latter with similar rocks in the eastern Avalon Peninsula.

A comprehensive geological investigation of the Bonavista Bay region was completed by Hayes (1948) for the

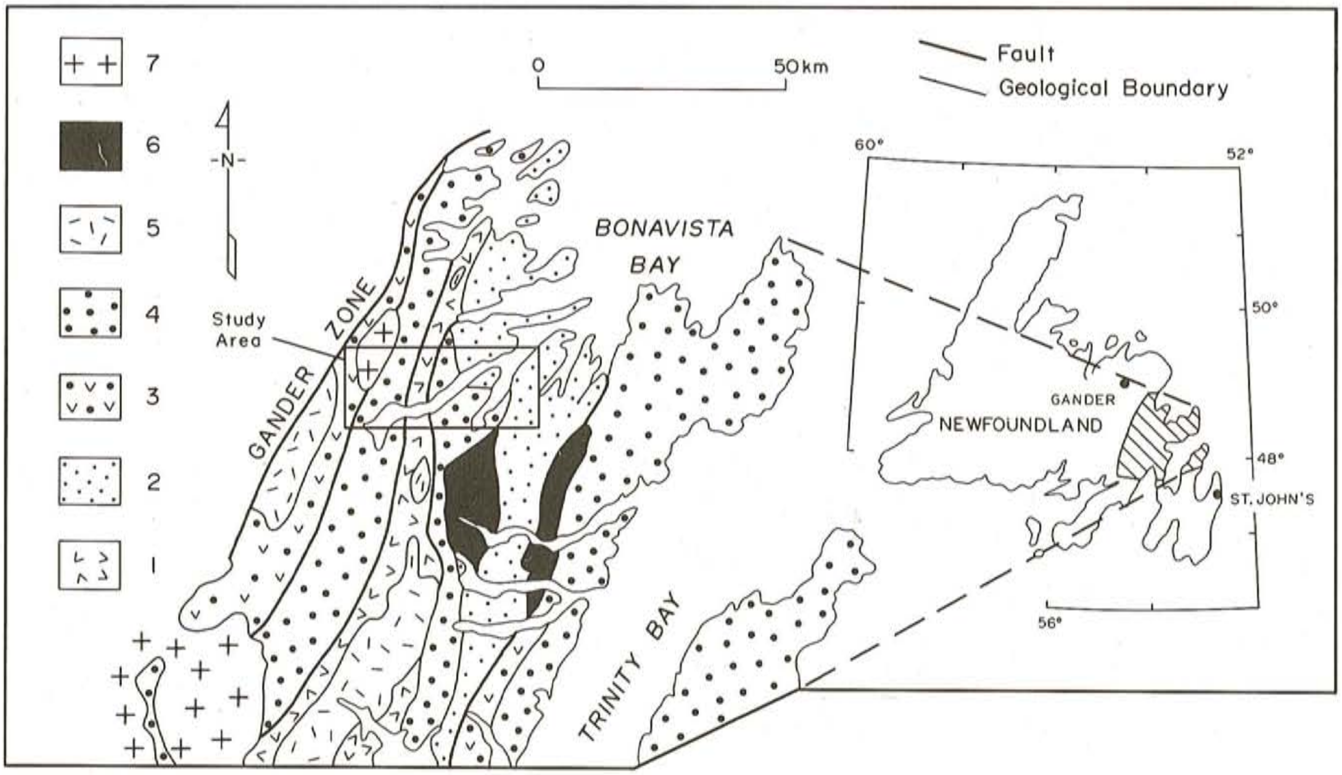


Figure 1. *Generalized geological map of the northwestern Avalon Zone showing the location of the study area (rectangle). 1: Love Cove Group, 2: Connecting Point Group, 3: Musgravetown Group—mainly volcanic rocks, 4: Musgravetown Group—mainly terrestrial sedimentary rocks, 5: Precambrian granite, 6: Cambrian sedimentary rocks, 7: Devonian granite.*

Newfoundland Geological Survey. Within the Precambrian succession, he recognized a regionally significant, angular unconformity separating an older, mainly argillaceous sequence (the '..slate rock...' of Jukes), which he named Connecting Point Group, from a younger, coarse-grained, red clastic sequence, which he named Musgravetown Group. Widmer (1949) expanded upon Hayes' work in and around the Clode Sound area. There, he recognized a third major Precambrian stratigraphic unit, characterized by pervasively foliated, metavolcanic and metasedimentary rocks, which he informally named 'Love Cove schists formation'. Christie (1950) produced a 1:125 000 map and summary account of the geology of the Bonavista map area (NTS 2/C), which incorporated observations made in the western half of the present study area. Christie reverted to Hayes' earlier two-fold division of the Precambrian stratified succession. He noted, however, that the Connecting Point—Musgravetown group contact, although unconformable in some parts of Bonavista Bay, was conformable elsewhere.

Jenness (1954, 1957, 1958, 1963) mapped an area between Clode Sound and Alexander Bay for the Newfoundland Geological Survey, and subsequently undertook mapping of the Bonavista (NTS 2C) and westerly adjacent Terra Nova (NTS 2D) map area for the Geological Survey of Canada. His work in the Bonavista map area constituted a re-examination of critical portions of the area previously surveyed by Christie between 1949 and 1953. Jenness (1963) formally established a tripartite division of the late Precambrian rocks of western Bonavista Bay, retaining Hayes' earlier designations and elevating Widmer's Love Cove schists formation to group status. He maintained that the Love Cove Group, which he mapped in separate, eastern and western belts, was (1) the oldest stratigraphic unit in the region, and (2) deformed prior to deposition of the Connecting Point Group. He concurred with Christie's (1950) view that the Connecting Point Group was tectonized before the Musgravetown Group was deposited.

On the basis of studies in the nearby Alexander Bay area, Younce (1970) concluded that the Love Cove Group represented deformed equivalents of the Musgravetown Group, thereby challenging Jenness's earlier view. Hussey (1979), working in the vicinity of Clode Sound, contended that rocks assigned by Jenness and Widmer to the Love Cove Group lie conformably beneath the Musgravetown Group. Reusch and O'Driscoll (1987), however, reinterpreted the same Love Cove—Musgravetown group boundary as a fault, with the older Love Cove Group thrust southeastward over the younger Musgravetown Group. The thrust boundary is displaced by later vertical movements.

O'Brien and Knight (1988) and O'Brien and Holdsworth (1992), mapping in the St. Brendan's (NTS 2C/13) and Glovertown (NTS 2D/9) map areas, respectively, demonstrated that the metavolcanic successions assigned by Jenness to the Love Cove Group include rocks of significantly different age and stratigraphic position. Near the northern

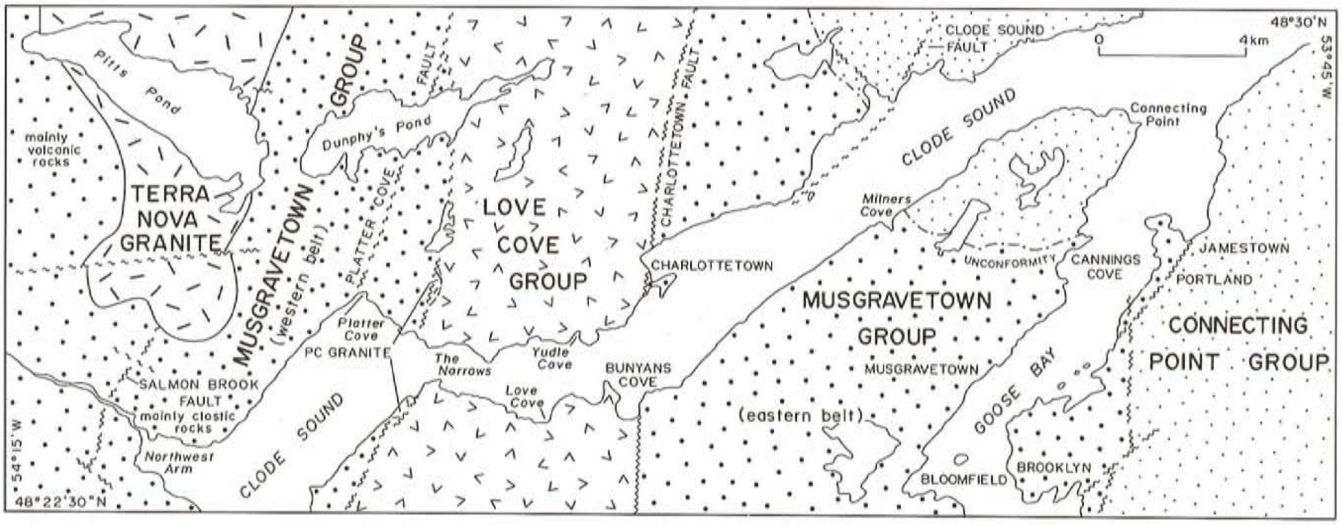


Figure 2. *Major geologic divisions of the study area.*

end of Jenness' eastern Love Cove belt, schistose volcanic rocks, dated at 620 ± 2 Ma (O'Brien *et al.*, 1992), lie conformably beneath Connecting Point Group strata (O'Brien and Knight, 1988). Farther west in the Glovertown map area, rocks previously assigned by Jenness' western Love Cove belt were shown to include tuffs and flows that, locally, are intercalated with parts of the Musgravetown Group (O'Brien and Holdsworth, 1992). The latter are correlated with strata that unconformably overlie the Connecting Point Group and pass upward into Cambrian strata. Thus, some if not all of 'Love Cove' rocks in Jenness' western belt are significantly younger than the dated 620 Ma volcanic succession in the eastern Love Cove belt.

SYNOPSIS

The southern reaches of Bonavista Bay (Figure 1) encompass the type areas of the three principal late Precambrian lithostratigraphic units of the western Avalon Zone, namely: the Love Cove Group (Widmer, 1949; Jenness, 1963), the Connecting Point Group (Hayes, 1948), and the Musgravetown Group (Hayes, 1948). A simplified map displaying the disposition of these groups and spatially associated plutonic rocks in the general area of Clode Sound and Goose Bay, together with the major faults, is given in Figure 2.

Rocks herein assigned to the Love Cove Group include pyroclastic and epiclastic volcanic lithofacies of chiefly intermediate composition, associated with arenaceous sedimentary deposits of probable, shallow-marine origin. In almost all areas, these rocks contain a penetrative ductile tectonic fabric, overprinted in places by second-generation folds and fabrics, and by a wide array of later brittle features. The Love Cove Group is intruded by small bodies of little-deformed, quartz-rich equigranular granite and is also host to a large number of pretectonic to posttectonic mafic dykes. All other external boundaries are tectonic.

The Connecting Point Group within this area is composed mainly of fine-grained, marine siliciclastic rocks, and is characterized by the extensive development of shale-rich, distal turbidites. South of the Clode Sound Fault, the group forms an overall southward-younging succession. Connecting Point Group strata are moderately to steeply dipping, extensively homoclinal and, locally, tightly folded. Pretectonic and posttectonic mafic dykes are widespread.

The Musgravetown Group unconformably overlies the Connecting Point Group. The Musgravetown Group is a coarse-grained, mainly red, fluviatile clastic succession that occupies two belts or subbasins, separated by the north-trending tract of the Love Cove Group. In the east, it contains a basal conglomerate unit, overlain by a bimodal volcanic sequence, capped by red beds. These strata are affected by broad open folds and brittle faults; metamorphic grade of these rocks is prehnite–pumpellyite (Hussey, 1979). The western belt of the Musgravetown Group consists of approximately equal proportions of volcanic and clastic rocks of mainly terrestrial and, to a lesser extent, shallow-marine origin. These are inhomogeneously deformed and record an overall westward increase in the degree of deformation.

In the northwestern corner of the map area, the Musgravetown Group is intruded posttectonically by a coarse-grained, porphyritic granite pluton, the Terra Nova Granite (Strong *et al.*, 1974). A zone of cordierite hornfels, at least 1 km wide, is developed in sedimentary rocks adjacent to this granite.

The region is traversed by numerous faults, most of which are high-level brittle features. The most notable of these are the Charlottetown, Salmon Brook and Platter Cove faults (Jenness, 1963) and the unnamed structure that defines the western boundary of the Love Cove Group. Some of these may represent brittle reactivation of earlier, more fundamental structures.

UNIT DESCRIPTIONS

LOVE COVE GROUP

The Love Cove Group occupies a north-trending, 6- to 8-km-wide band in the central portion of the study area (Figure 3). It is bounded to the east by the Charlottetown Fault (Jenness, 1963), which juxtaposes folded Love Cove Group schists with gently dipping, unfoliated, Musgravetown Group red beds. The group's western boundary is a brittle fault that juxtaposes both metavolcanic and metasedimentary Love Cove rocks with either folded, shallow-marine Musgravetown strata or granite.

The most diagnostic features of the Love Cove Group are 1) the widespread development of chiefly subaqueous, pyroclastic and associated epiclastic sedimentary lithofacies, 2) the almost ubiquitous presence of chlorite- to biotite-grade, ductile tectonic fabrics, and 3) the extensive occurrence of second generation folds and fabrics. Within the study area, the Love Cove Group is tentatively divided into a mixed pyroclastic complex (Unit 1) and a dominantly volcanosedimentary succession (Unit 2). These correspond, approximately, with the White Point and Thorbourn Lake formations, respectively, of Hussey (1979). This informal nomenclature has not been adopted here.

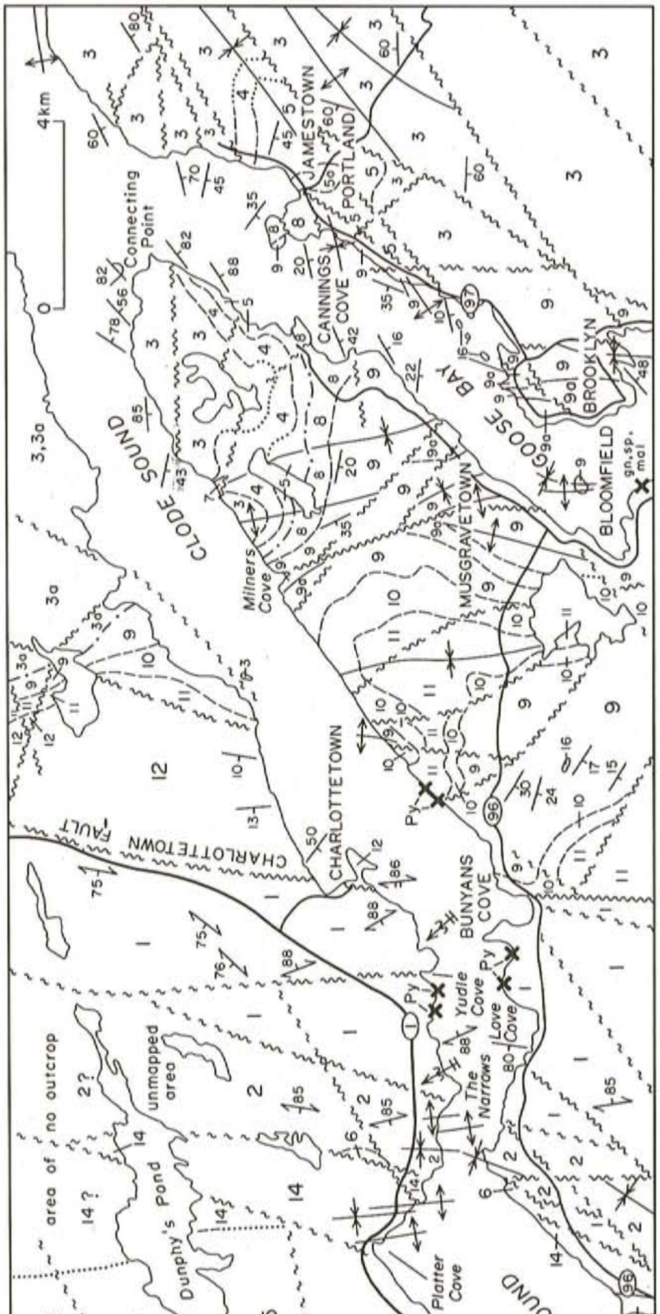
Unnamed Volcanic Division (Unit 1)

Unit 1 is the more extensive and easterly of the two divisions of the Love Cove Group. It is primarily composed of a diverse suite of pyroclastic rocks and contains relatively few massive flows. The pyroclastic deposits are chiefly rhyodacitic to dacitic; mafic rock types are rare. Volcanogenic clastic rocks are also present but are much less abundant than the volcanic assemblage. The unit is host to at least two generations of mafic dykes.

The paucity of primary layering and younging criteria, the lack of identifiable marker beds, and extensive ductile and brittle deformation, together preclude the establishment of a useful stratigraphic subdivision for this unit. A minimum of 6 component lithofacies are recognized; one of these is defined on structural and metamorphic character, rather than original protolith. The regional stratigraphic interrelationships amongst the other five are uncertain.

Lithofacies 1a: Lithic tuff–tuff breccia–agglomerate

These pyroclastic rocks are the most widespread and single most diagnostic lithofacies of the Love Cove Group. A great lithological variability is recognized but all component rock types are thought to bear a direct genetic relationship to each other. In the western part of Unit 1, the predominant rock types are grey and green, lithic-rich intermediate crystal tuff of this lithofacies. These are characterized by epidotized clasts, wrapped by a pervasive ductile fabric. Coarse-grained breccias and agglomerate of similar composition are associated with the above tuffs on both regional and outcrop scales. In a few localities, the pyroclastic rocks are interlayered with fine-grained vitric tuffs, porcellanitic tuffs



LEGEND (for Figure 3)

DEVONIAN ?

TERRA NOVA GRANITE

17 *Mainly massive, pink to buff, coarse-grained, K-feldspar porphyritic biotite granite; minor pink, fine- and medium-grained, K-feldspar porphyritic granite; rare equigranular granite and aplite*

LATE PRECAMBRIAN

16 *Dark-grey, fine-grained diorite; medium- to coarse-grained gabbro*

MUSGRAVETOWN GROUP (Units 8 to 15)

Western belt (Units 13 to 15)

15 *Red, purple and maroon, locally micaceous sandstone and lesser siltstone; minor coarse-grained red sandstone and pebble to cobble conglomerate; minor red shale and grey sandstone*

14 *Green, yellow, buff and grey, crossbedded sandstone; minor pebble conglomerate;* **14a**, *basalt*

13 *Red, yellow, buff, and purple, massive to strongly foliated tuffs and flows of felsic and intermediate composition; unseparated red felsic ash-flow tuff and banded rhyolite; minor mafic tuffs*

Eastern belt (Units 8 to 12: numbering reflects stratigraphic order within the belt but does bear on the relative ages of eastern and western belts of the Musgravetown Group)

12 *Unseparated red sandstone, red and maroon pebble to cobble conglomerate, and grey and green sandstone*

11 *Red, pink and pale-purple rhyolitic and rhyodacitic flows, ash-flow tuff and related pyroclastic rocks, including rheo-ignimbrite and related autobrecciated tuffs and flows; parataxitic and eutaxitic banded pumice-rich and pumice-poor tuff, flow-banded and massive rhyolite; unseparated purple and red, fine-grained, feldspar porphyry and felsite*

10 *Mainly dark-grey and green, locally maroon, vesicular basalt; minor basaltic breccia, mafic tuff and agglomerate; minor red sandstone and conglomerate; mafic lahar, conglomerate and mafic tuff*

9 *Red and maroon, polymict, pebble, cobble and boulder conglomerate; minor red and lesser grey and green sandstone and siltstone; locally contains thin, unseparated mafic flows;* **9a**, *basalt and mafic breccia*

8 *Pale-green cobble and pebble conglomerate; minor green and grey sandstone; rare red sandstone*

7 *Dark-green and grey, medium-grained hornblende gabbro*

6 *Equigranular, quartz-rich, hornblende - biotite granite*

CONNECTING POINT GROUP (Units 3 to 5)

5 *Green sandstone and minor granule conglomerate, grey and green siltstone;* **5a**, *minor red sandstone and siltstone*

4 *Pale-grey and green, interbedded, granule, pebble and cobble conglomerate and sandstone*

3 *Grey, black and grey-green, thin- to medium-bedded, fine-grained sandstone, siltstone and shale; minor medium- to thick-bedded green sandstone and siliceous siltstone; minor chert, tuff and tuffaceous sandstone;* **3a**, *grey and black phyllite, shale, siltstone and sandstone*

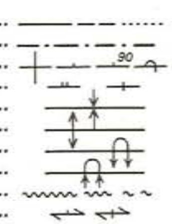
LOVE COVE GROUP (Units 1 and 2)

2 *Grey meta-arenite, phyllite, tuffaceous sandstone and conglomerate, siltstone and chert; minor unseparated metavolcanic rocks*

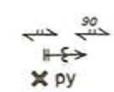
1 *Strongly foliated, chlorite- to biotite-grade, felsic to intermediate metavolcanic rocks of mainly pyroclastic origin; sericite schist and phyllite; minor quartz-phyric rhyolite flows, mafic flows and tuffs, and epiclastic metasedimentary rocks; unseparated pretectonic and posttectonic diabase dykes*

KEY

Geological contact (defined, approximate, assumed)
Unconforable contact
Bedding, tops known (horizontal, inclined, vertical, overturned)
Bedding, tops unknown (inclined, vertical)
Axial trace of syncline
Axial trace of anticline
Axial trace of overturned anticline
Axial trace of overturned syncline
Fault (defined, approximate, assumed)
Cleavage or foliation: first generation (inclined, vertical)



Cleavage or foliation: second generation (inclined, vertical)
Second-generation folds (arrow in direction of plunge)
Mineral occurrence



ABBREVIATIONS

py .... *pyrite*
gn .... *galena*
sp .... *sphalerite*
mal .... *malachite*

Figure 3. *Preliminary map of the (NTS) 2D/8NE–2C/5NW area.*

and volcanogenic sediments (see below). Rocks of this lithofacies are host to numerous pretectonic and syntectonic mafic dykes, that are principally diabasic in composition (Plate 1).

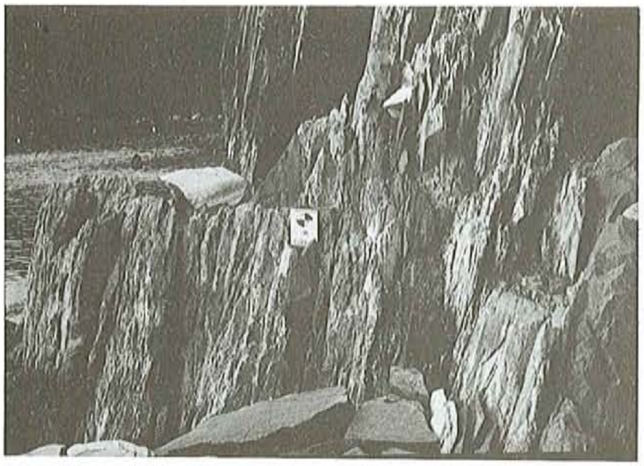


Plate 1. *Platy and schistose, felsic metavolcanic rocks of the Love Cove Group (Unit 1) containing foliated metadiabase dykes, north shore of Clode Sound.*

Lithofacies 1b: Flows and crystal-rich ash-flows

This lithofacies is more regionally homogeneous than lithofacies 1a. The primary rock type is white-, buff- or pale-brown-weathering, fine-grained, crystal- and crystal-lithic tuff of rhyolitic to dacitic composition. Relict welding textures in the tuffs are identifiable in lower strain augen. More massive flow rocks are intimately associated with the ash-flows. These include K-feldspar-bearing, plagiophyric and aphyric varieties, and at least one coarse-grained, quartz-rich rhyolite flow.

Lithofacies 1c: Felsite-bearing breccia

Massive to crudely bedded, medium- to coarse-grained, polylithic breccias are the most distinctive and readily identifiable lithofacies within Unit 1, and are found only in its easternmost part. Fragments of orange-brown felsite and rhyolite occur together with dark-grey tuff and a lesser amount of other felsic volcanic clasts in a grey-green matrix. Spatially associated with the breccias is a distinctive dark-grey tuff of intermediate composition. The tuff occurs as clasts in the associated, coarser grained rocks. Both the tuffs and the breccias are strongly flattened; clasts in the breccias have length-to-width ratios up to 20:1.

Lithofacies 1d: Volcanogenic sediment

Volcanogenic sedimentary rocks represent a subordinate element of Unit 1. In the eastern part of the unit, fine-grained, pale grey-green, tuffaceous sandstone is locally associated with the lithofacies 1c breccias. Immediately east of the Narrows on Clode Sound, similar sedimentary rocks are spatially associated with lithofacies 1a volcanic rocks. The tuffaceous sandstone occurs together with bedded, cherty tuff and porcellanite and thinly laminated, cherty siltstone. Here, the bedded rocks are locally interlayered with fine-grained mafic tuffs and narrow mafic sills. Near Charlottetown, similar porcellanites are interstratified with greywackes and fine-grained lithic tuffs.

Lithofacies 1e: Mafic volcanic rocks

Mafic extrusive and associated hypabbysal rocks are the least widespread lithofacies, and are extensively developed only along the north shore of Clode Sound. Mafic aquagene tuffs and basaltic breccia, both of which are extensively chloritized and epidotized, and rare mafic flows are exposed several hundred metres east of Yudle Cove. Nearer to Yudle Cove, the mafic rocks are succeeded westward by rhyodactic ash-flows and eastward by breccia of lithofacies 1c. Smaller, widely scattered exposures of metabasic rocks are associated with the tuffaceous epiclastic assemblage about 1 km east of White Point.

Lithofacies 1f: Sericite schist

These are typically buff to pale-yellow or brown, platy or schistose rocks, derived from felsic volcanic and epiclastic sedimentary protoliths. They are locally traversed by fabric-parallel quartz veins that vary from 1 mm to 25 cm thickness. The schists vary in extent from narrow (less than 1 m), irregular zones, within more massive rock types, to mappable subunits several tens of metres in thickness. In most areas, these are host to locally extensive hydrothermal alteration and disseminated pyrite mineralization (see below and Figure 3). The schists are deformed by second-phase folds and a variety of minor brittle structures.

Unnamed Sedimentary Division (Unit 2)

Unit 2 is composed chiefly of highly strained, chlorite- to biotite-grade, tuffaceous metasedimentary rocks of characteristically arenaceous composition. These rocks contain the penetrative, closely spaced fabric, characteristic of the Love Cove Group, and in many areas are isoclinally folded. Unit 2 is most readily described in terms of two component lithofacies.

Lithofacies 2a: Arenite-conglomerate

These volcanogenic rocks, which are the most widespread and most diagnostic lithofacies of Unit 2, are mainly grey, grey-green and buff, coarse-grained tuffaceous arenites. They are plagioclase-rich and contain a major component of subangular, felsic to mafic volcanic detritus. Macroscopic magnetite is a prominent detrital component, locally. The rocks are moderately to poorly sorted and in many areas, primary sedimentary structures, if originally developed, are now masked by a strong, closely spaced tectonic fabric. Fine- to medium-grained, well-foliated, volcanic-rich conglomerates are interstratified with the arenaceous sandstones (Plate 2).

Plate 2. *Foliated, tuffaceous, pebble conglomerate, Love Cove Group (Unit 2), north shore of Clode Sound.*

Lithofacies 2b: Ribbon-banded siltstone

White- to pale-grey-weathering, siliceous siltstone, chert and very fine-grained sandstone are the predominant rock types in the eastern part of this unit. These are thin-bedded and have a distinct ribbon-banded appearance. Typically, beds have sharp, flat bases and, in most cases, display little thickness variation. Internal bedding features include parallel laminations and crosslaminae. These fine-grained rocks locally contain interbeds of vitric tuff and coarser grained arenite.

The eastern boundary of Unit 2 is marked by brittle faults that separate it from schistose metavolcanic rocks of Unit 1. Interbanded tuffaceous sedimentary and pyroclastic rocks occur adjacent to this contact on Clode Sound, and their presence is consistent with an originally conformable relationship between Units 1 and 2. North of Clode Sound, the western boundary with the Musgravetown Group is a brittle fault. South of there, brittle faults separate Unit 2 arenite from a narrow fault-wedge of granite (see Unit 6 below), and farther south again, from metavolcanic rocks, herein included with Unit 1. The original contact with the granite was likely intrusive, given the thermally altered appearance of the adjacent sedimentary rocks and the presence, on the north shore of Clode Sound, of narrow granite dykes within the arenites.

CONNECTING POINT GROUP

The Connecting Point Group occurs only in the eastern half of the study area, where it lies to the east and north of the Musgravetown Group. It is not in contact with the Love Cove Group in this area. The base of the Connecting Point Group is unexposed and its top is marked, at least locally, by an angular unconformity developed at the base of the overlying Musgravetown Group. The group's distinctive character is defined primarily by the widespread development of marine turbidites.

The Connecting Point Group consists primarily of both sandy and shale-rich turbidites (Unit 3; Figure 3). In the region south of Clode Sound, the shale-rich turbidites are succeeded by a thin unit of grey conglomerate (Unit 4; Figure 3), provisionally included within the Connecting Point Group. The coarse-grained rocks are overlain by a distinctive green and pale-grey sandstone sequence of possible shallow-marine origin (Unit 5; Figure 3), which is also included in the group in a provisory fashion.

Unnamed Turbidite Division (Unit 3)

The best exposed and most continuous stratigraphic sections of this unit are found on the peninsula between Clode Sound and Goose Bay and on the east shore of Goose Bay, north of Jamestown (Figure 3). The base of Unit 3 is unexposed and its top is drawn at the first appearance of significant amounts of conglomerate. The latter contact is faulted in most areas.

The lower part of the Goose Bay section consists of at least 200 m of white- to pale-brown-weathering, grey and grey-green sandy turbidites. The sandstones are graded, locally display loaded bases, and occur in variably developed, mostly irregular, thick- to thin-bedded (cf. Ingram, 1954) cycles. At this level, shales are not extensive and green siltstone occurs as thin beds intercalated with the sandstones.

The sandy turbidites are succeeded by thin- to very thin-bedded (cf. Ingram, 1954), dark-grey and black, shale-rich turbidites. These are disposed in a number of cycles. A typical cycle begins with thin-bedded siltstone and shale, that pass upward into thick-bedded, shale-rich and successively shale-poor turbidites. The latter are capped by thin-bedded, shaley turbidites. A minimum thickness of 300 m is exposed in essentially continuous succession at Goose Bay. Elsewhere, the sequence is disrupted by numerous crossfaults, thus its total thickness is unknown.

In the vicinity of Connecting Point, on the headland between Clode Sound and Goose Bay (Figure 3), between 1000 and 1300 m of stratigraphically continuous section is exposed. These strata lie near the top of Unit 3. The lowest part of this succession is faulted, to the east, against thin-and medium-bedded (cf. Ingram, 1954) turbidites, similar to the succession described above. These are overlain by grey, siliceous siltstones, fine-grained sandstones and argillites, which are locally rippled and disposed in thick- to thin-bedded cyclic sequences (Plate 3). These strata locally contain thin, grey, graded tuff beds. The argillaceous rocks are succeeded by thin- to medium-bedded, grey-green, graded and finely crosslaminated sandstone and siltstone. Pale-green- and pale-brown-weathering sandstone beds occur locally at this level. Upward, the dark-grey and pale-green sandstones predominate. Millimetre-scale tuff beds are widely dispersed throughout this part of the succession and a distinctive bright-green-weathering siltstone bed occurs near its top. The succession is capped by very thin-bedded, dark-grey siltstone.

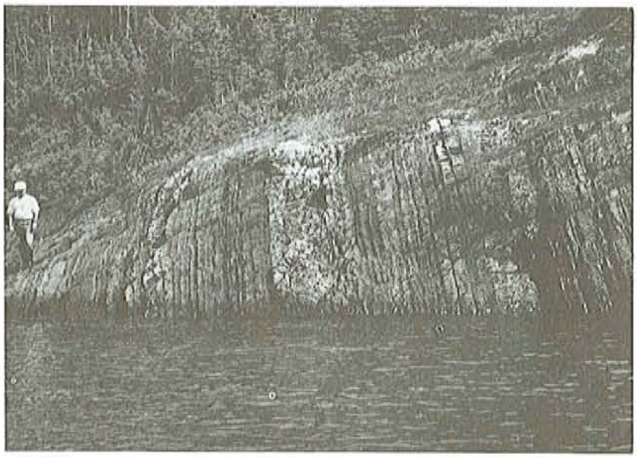


Plate 3. *Thin- to medium-bedded, shale-rich turbidites containing thicker sandy units, Unit 3 of the Connecting Point Group, south shore of Clode Sound.*

North of Clode Sound, thin-bedded and shale-rich turbidites, containing rare thick-bedded sandstone units are exposed. This section is significantly more deformed than the exposures south of the Sound, and in many locations, the rocks are variably phyllitic (subunit 3a, Figure 3).

Unnamed Conglomerate Division (Unit 4)

Unit 4 consists of coarse-grained, siliciclastic rocks that lie close to the top of the Connecting Point Group. Its thickness is unknown but is likely less than 200 m. Pale-green granule, pebble and cobble conglomerates that comprise the unit are typically massive to crudely stratified. In a few localities, well-bedded conglomerates are interlayered with coarse-grained green sandstone.

The base of Unit 4 is regionally concordant with the underlying Unit 3 turbidites, although where this contact is exposed (on the shores of Goose Bay), it is modified by late, brittle crossfaults. On the south shore of Clode Sound, however, the conglomerate unit appears to be bounded gradationally by turbidites below and pale-green sandstone and shale above. The conglomerate is much like the basal green conglomerate division of the Musgravetown Group (see Unit 5, below). Because of its apparent position beneath the sub-Musgravetown unconformity, however, it has been included, tentatively, within the Connecting Point Group.

Unnamed Green Sandstone Division (Unit 5)

Southeast of Clode Sound, a westward-thinning sequence of pale-green sandstone (Unit 5; Figure 3) overlies conglomerate assigned to Unit 4 of the Connecting Point Group. This sequence attains an estimated maximum thickness of about 500 m in the vicinity of Jamestown (Figures 2 and 3).

Fine-grained, well-sorted, green sandstones are the predominant rock types within the unit. These medium-bedded rocks contain interbeds of thicker, internally laminated sandstone, mainly in the upper part of the succession. The sandy and shale-rich turbidites common elsewhere in the Connecting Point Group are absent here. In what appears to be the uppermost part of this unit near Jamestown, red sandstone and siltstone (subunit 5a) is interbedded with the green sedimentary rocks. In the same area, a northwest-trending brittle fault separates this succession from green and red conglomerates at the base of the Musgravetown Group.

Farther to the west, the unit contains an increasing proportion of gritty sandstones and granule conglomerate. Near Cannings Cove, these coarse-grained rocks are interlayered with pale-brown-weathering, medium-bedded sandstone, like that seen at lower stratigraphic levels within the Connecting Point Group. On both shores of Goose Bay, the contact of Unit 5 with underlying conglomerate is apparently conformable.

PRECAMBRIAN INTRUSIONS

Unnamed Hornblende–Biotite Granite (Unit 6):

A small (< 0.5 km^2), fault-bounded wedge of equigranular, quartz-phyric, hornblende–biotite granite is exposed along the south shore of Clode Sound, approximately 1 km west of the Narrows. A few, small outcrops of finer grained, compositionally similar granite occur about 3 km farther north; both bodies are sited along the western boundary of the Love Cove Group. In each case, the granitic rocks are significantly less deformed than the adjacent metavolcanic and metasedimentary rocks.

Hussey (1979) interpreted the larger granite body as a satellite pluton of the Georges Pond Granite, the main body of which intrudes the Love Cove Group several kilometres to the south of Clode Sound, in the Blandford's ridge area. The Georges Pond Granite was interpreted by Hussey (1979) as a pretectonic intrusion, comagmatic with the Love Cove Group. However, there is a marked contrast in the degree of deformation between the highly strained Love Cove Group rocks and the adjacent granite, which occurs as narrow sheets. This appears to be more consistent with a posttectonic origin for the granite exposed in this area (see Tectonic History, below), as competency contrast may not be a factor in this situation.

Narrow, fault-bounded sheets of pink and red felsite and very fine-grained granite porphyry (not separated on Figure 3) intrude the Love Cove Group near its eastern boundary with the Musgravetown Group. These rocks lie adjacent to the Charlottetown Fault and are highly fractured. Their relationship to the granite along the western margin of the Love Cove Group in unknown.

Unnamed Hornblende Gabbro (Unit 7)

A small body of medium-grained, hornblende gabbro, several tens of metres in width, is intrusive into the Connecting Point Group on the south shore of Clode Sound. This dark-green to grey gabbro is spatially associated with coarse-grained, plagiophyric diabase and is not extensively altered.

MUSGRAVETOWN GROUP

The Musgravetown Group occupies two regional belts, separated by the Love Cove Group. Although both belts are characterized by terrestrial sedimentary and volcanic rocks, there are significant lithological differences between them, suggesting they may have evolved as two separate subbasins. Rocks of the eastern belt lie with pronounced angular discordance upon the Connecting Point Group and are in tectonic contact with the Unit 1 of the Love Cove Group along the Charlottetown Fault. The western belt is separated from Unit 2 of the Love Cove Group by a brittle fault. Its western boundary is the ductile Dover Fault, which lies approximately 1 km northwest of Pitts Pond, on the adjacent Glovertown (NTS 2D/9) map area (O'Brien *et al.*, 1991a).

Eastern Belt (Units 8 to 12)

The eastern belt of the Musgravetown Group includes basal green and red boulder and cobble conglomerates (Cannings Cove Formation, of Jenness, 1963), designated as Units 8 and 9 on the accompanying map, succeeded by a bimodal, terrestrial volcanic succession (Units 10 and 11). The volcanic facies are interbedded with, and capped by, fine- to mainly coarse-grained, red clastic rocks. Red beds clearly demonstrated to overlie the volcanic rocks are here designated as Unit 12. However, some strata tentatively included within Unit 9 may, on the basis of future work, be reassigned to this younger unit.

Cannings Cove Formation (Units 8 and 9)

The Cannings Cove Formation consists of basal, coarse-grained green conglomerate (Unit 8), conformably overlain by red boulder to pebble conglomerate (Unit 9), containing mafic volcanic flows and green sedimentary strata. Regionally, the formation displays pronounced facies variations, and it appears to thicken from north to south across the Musgravetown Peninsula. In the type area around Cannings Cove, on the east side of the Musgravetown Peninsula (Figures 2 and 3), the formation is at least 700 m thick. Its strata become generally more flat-lying toward the south, where they are affected by broad open folding. This accounts, in part, for the broad surface extent of these rocks in that area. The Cannings Cove Formation is host to a large number of massive to variably cleaved mafic dykes.

One of the best preserved sections through the formation is exposed in the vicinity of Milner's Cove, on the south shore of Clode Sound (Figures 2 and 3), where approximately 500 m of section occur. Farther north, at Bread Cove, a similar thickness of section is preserved but there, the basal green unit is missing.

Unit 8 is a green conglomerate sequence that unconformably overlies the Connecting Point Group. Near Milner's Cove, this unit is less than 200 m thick. There, it consists of green, poorly sorted pebble and cobble conglomerate, intercalated with and succeeded by green, granule conglomerate and coarse-grained sandstone. A similar succession is exposed in and around Cannings Cove; the conglomerate facies is particularly well exposed at the headland north of Cannings Cove. There, the conglomerate contains well-rounded to subrounded clasts of a wide range of Connecting Point Group rocks, in addition to red and green felsite, variably coloured flow-banded rhyolites, vein quartz, jasper, black chert, red granite, grey granodiorite and a variety of fine-grained mafic clasts. There are numerous clasts containing pre-incorporation fabrics; epidote–chlorite-rich, low-grade metamorphic detritus is also common. Near the top of Unit 8, the conglomerates contain discontinuous, 10- to 15-cm-thick, tapered lenses of coarse-grained and pebbly sandstone. The conglomerate fines upward and is capped by a thin layer of red sandstone and shale.

Unit 9 lies in sharp, albeit gradational, contact above the basal green conglomerate (Unit 8), in the area south of Clode Sound. A thick section of this part of the Cannings Cove Formation is exposed along the south shore of Clode Sound. There, its basal beds are red and maroon, coarse-grained cobble and, less commonly, boulder conglomerate. These are massive to poorly bedded, rounded and clast-supported. A thin basalt flow occurs several tens of metres above the base of the unit. The main conglomerate appears to become finer grained (gradationally) upward in the succession. Interbeds of coarse-grained, well-bedded, red sandstone occur in the top 5 m of the conglomerate succession. A several-metre-thick basalt flow, the top of which is pervasively oxidized, occurs at this level in the succession. The basalt is succeeded by a 5-m-thick sequence of red and green sandstone and shale, and buff tuffaceous sandstone. A thin unit of irregularly laminated, grey, red and purple siltstone separate the latter rocks from a 4-m-thick subunit of red sandstone and buff pebble conglomerate. The top of Unit 9 in this area consists of thinly laminated grey, green and red siltstone.

North of Clode Sound, Unit 9 is represented by coarse-grained, red and maroon fanglomerate and conglomerate (Plate 4). These rocks lie adjacent to folded Connecting Point strata, although the contact between the groups is covered. The coarse-grained redbeds are clast-supported and contain very little sandy material but are, nevertheless, well stratified. Their detrital assemblage is similar to that documented elsewhere in the Cannings Cove Formation, although vein quartz appears to be more prevalent here than in other areas.

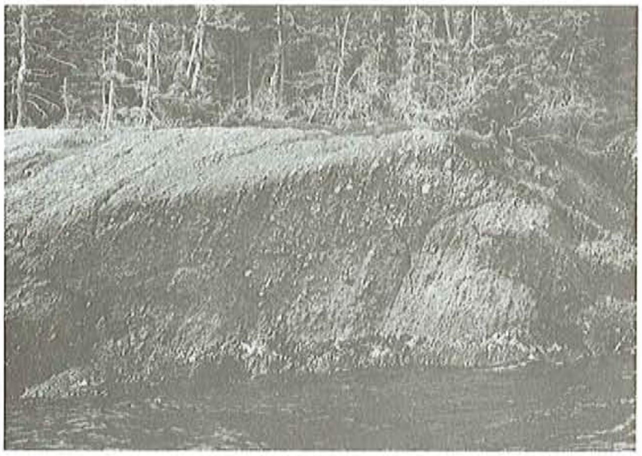


Plate 4. *Bedded, coarse-grained conglomerate (Unit 9) at the base of the Musgravetown Group near Bread Cove.*

Around Goose Bay, gently dipping to near-horizontal, red conglomerates are predominant. Mafic volcanic intercalations occur in at least three different stratigraphic levels within these red beds. Near Brooklyn, a coarse-grained, lahar-like facies, containing mixed volcanic and green sedimentary blocks, occurs with basalt and forms a mappable subdivision (subunit 9a; Figure 3) within the clastic rocks. Although they are tentatively included within the Cannings Cove Formation, these rocks could conceivably represent facies equivalents of stratigraphically higher volcanic units (see below).

The basal contact of the Cannings Cove Formation is exposed approximately 500 m northeast of Milners Cove, where green, cobble- to boulder-conglomerate lies directly upon cleaved, steeply dipping and folded Connecting Point Group strata (Plate 5). Near James Head and at Cannings Cove, the formation is faulted against the uppermost unit of the Connecting Point Group.

Plate 5. *Angular unconformity separating basal Musgravetown Group conglomerate (Cannings Cove Formation) from the underlying turbidites of the Connecting Point Group, south shore of Clode Sound, near Milner's Cove.*

Unnamed Volcanic Division (Units 10 and 11)

Units 10 and 11 denote the mafic and overlying felsic parts, respectively, of the bimodal volcanic succession that overlies the Cannings Cove Formation. North of Clode Sound, the volcanic units form a 500- to 1500-m-wide north-northeast- to north-northwest-striking and moderately west-dipping, homoclinal succession. As is the case with the underlying Cannings Cove strata, dips become progressively shallower southward across the map area. In much of the region between Bunyan's Cove and Musgravetown, the flows are near-horizontal. They thus underlie a much larger area there than in the north.

Unit 10 primarily consists of little-deformed, dark-green, dark-grey and locally maroon, augite-bearing, amygdaloidal basalt (Plate 6). These are subaerial flows that range in thickness from 20 cm to 2 m. The flows are ubiquitously vesicular, although the degree of vesicularity is highly variable. Calcite, chlorite, quartz and hematite are vesicle-filling phases. Minor aphyric zones are present within these flows, particularly in the thicker varieties. Rubbly flow tops and zones of vesicle alignment are common, as are variably developed liesegang bands. Red, sandy, inter-flow material occurs within the flow-top breccias. Similar sandstone locally forms interbeds within the predominantly volcanic unit.

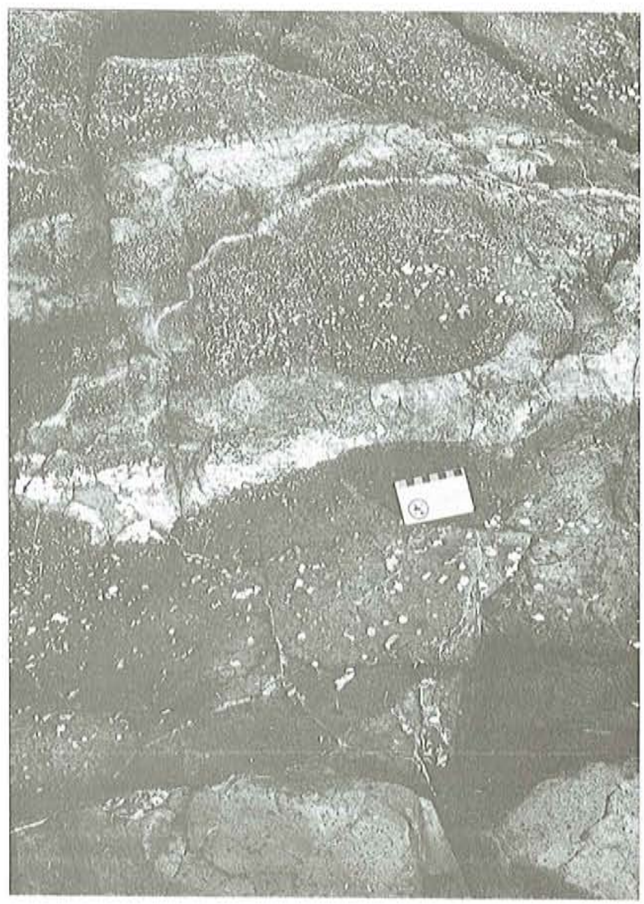


Plate 6. *Amygdaloidal basalt of the Musgravetown Group (Unit 10).*

Unit 11 consists of little-deformed felsic flows and pyroclastic rocks. Hussey (1979) has demonstrated that these rocks are peralkaline in composition, and geochemically analogous (in terms of trace-element concentrations) to pantellerites and commendites. In detail, the unit is lithologically diverse, although it has not been subdivided regionally. Its most diagnostic components are welded pumice-rich and pumice-poor, ash-flow tuff and related pyroclastic rocks of rhyolitic to rhyodacitic composition. These include rheo-ignimbrite and related rheomorphic tuffs and autobreccia. The pyroclastic facies are spatially associated with red, pink and pale-purple, rhyolitic and rhyodacitic flows. These characteristically display finely spaced and intricate flow-folded banding (Plate 7). Unseparated on the accompanying map are bodies of purple and red, fine-grained, feldspar porphyry and felsite; these appear to be of minor extent.

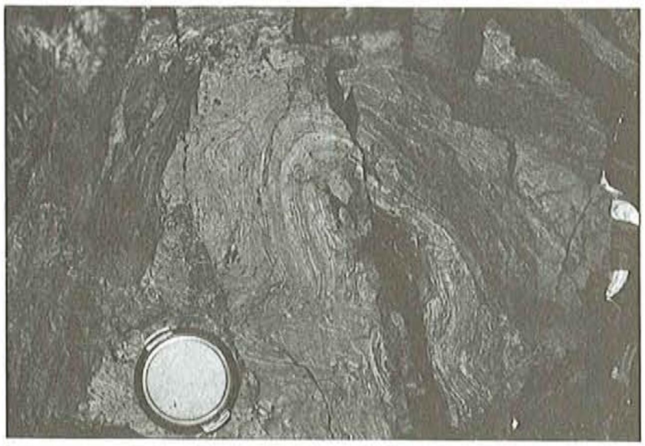


Plate 7. *Flow folds in banded rhyolite, Musgravetown Group (Unit 11).*

Jenness (1963) correlated these volcanic rocks with the Bull Arm Formation exposed farther south in the Trinity Bay area. Hussey (1979) questioned this, noting that the correlated rock units display sharply contrasting chemical signatures. He proposed the informal name Clode Sound formation to denote volcanic rocks that are part of the succession described here. The author concurs with Hussey's misgivings. Nevertheless, establishment of formal nomenclature will await a fuller investigation of the units' contacts throughout the region, and in particular, their separation—regionally—from volcanic rocks lower in the stratigraphic pile.

Unseparated Sedimentary Rocks (Unit 12)

On the north shore of Clode Sound, red sandstone and red and maroon pebble to cobble conglomerate overlie rhyolite of Unit 11. The sedimentary rocks locally contain planar crossbeds and muddy rip-ups. The redbeds become younger toward an adjacent succession of thin-bedded and wispy-laminated, red and grey sandstone, which contain ripple marks and mudcracks and are rich in detrital muscovite. These rocks are tentatively viewed to be overlain by a succession that includes grey and green granule conglomerate at the base, overlain by rippled and locally slumped green sandstones. Farther west and north, this unit is dominated by fine-and coarse-grained red clastic rocks.

Western Belt (Units 13 to 15)

The western belt of the Musgravetown Group is divided into three units. An extensive band of felsic volcanic rocks (Unit 13) in the west is faulted along its eastern boundary against a belt of red sandstone and shale (Unit 15), which is, in turn, succeeded eastward by a narrow band of grey and yellow-green sandstone (Unit 14). The relative stratigraphic order of these divisions has not been clearly established within the map area. The degree of deformation of this subbasin is highly variable, and is most intense west of the tectonic contact of Units 13 and 15.

Unnamed Volcanic Division (Unit 13)

Unit 13 consists of variably deformed felsic and mafic volcanic rocks of primarily subaerial origin that form the westernmost division of the western Musgravetown Group subbasin. No further stratigraphic subdivision of the unit has been made and it is possible that lithologically similar rocks of significantly different ages occur within it. Three lithofacies can be distinguished within Unit 13; these are not separated on the accompanying map. They correspond roughly to the three divisions established by O'Brien *et al.* (1991a) in the same volcanic belt, along strike to the northwest in the adjacent Glovertown map area.

Lithofacies 13a: variegated fragmental rocks

Typical of this lithofacies are variegated, mainly maroon and yellow, feldspar-rich, fragmental rocks, which are spatially associated with red, yellow and purple, welded ash-flow tuffs. Red, buff and yellow-brown tuffaceous sandstone locally occurs with these tuffs. Most of these rocks contain a penetrative tectonic fabric. In several localities, red volcanic breccia containing blocks up to 50 cm in diameter, is exposed. This lithofacies is the most diagnostic of the three that comprise Unit 13.

Lithofacies 13b: schistose tuffs

This subdivision is typified by the presence of schistose, white, buff or pale-grey, tuffaceous volcanic rocks. In detail, this lithofacies is lithologically heterogeneous, largely due to the wide range in the relative proportion of lithic, vitric and crystal components. Grain size is also variable; fine- and medium-grained varieties are most common.

Lithofacies 13c: mafic rocks

These mafic tuffaceous rocks are of only minor areal extent. They are of variable grain size, extensively epidotized and chloritized, and well-cleaved.

A moderate to steeply dipping brittle displacement, the Salmon Brook Fault of Jenness (1963), defines the eastern boundary of Unit 13 in the southwest corner of the area. This structure may have incised an earlier northwest-dipping structural boundary between Units 13 and 15. The nature of this boundary and its ramifications for regional stratigraphic interpretations is discussed briefly below (see Unit 15).

The Salmon River Fault appears to be truncated by the Terra Nova Granite, although the contact is not exposed. Much of the eastern boundary of Unit 13 is defined by this pluton. The western boundary of Unit 13, which lies immediately northwest of the study area, is the brittle Terra Nova Fault (see Holdsworth and O'Brien, *this volume*), which defines the Gander–Avalon zone boundary in that region.

Unnamed Shallow Marine Sandstones (Unit 14)

Thin-bedded, wispy-bedded and ripple-drift cross-stratified sandstones are diagnostic of this unit (Plate 8); these locally display slump structures. The sandstones are yellow-green, buff and pale-green. Hornfelses related to the emplacement of mafic dykes into these rocks are extensively developed. South of Clode Sound, the green and buff sandstones are intercalated with minor amount of red sandstone, and contain interbedded basalt flows and a distinctive olistostrome-like volcanic-rich breccia (subunit 14a; Figure 3). The Platter Cove Fault (Jenness, 1963) and an unnamed brittle fault in the west, bound Unit 14. An extensive, pretectonic diabase dyke complex is sited in this unit. There appears to be at least two generations of dykes: early examples are extensively epidotized and chloritized and locally injected by more massive, less-altered diabase.

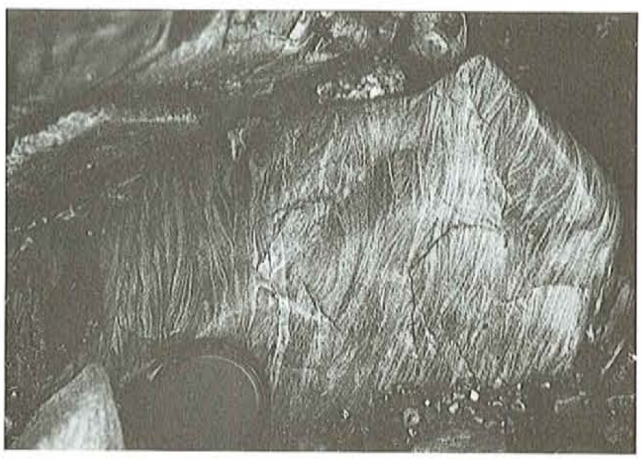


Plate 8. *Cross-stratified sandstone and siltstone, Musgravetown Group (Unit 14), east of Platter Cove.*

Unit 14 is lithologically like the Rocky Harbour Formation of Jenness (1963) and McCartney (1967). Although the stratigraphic relationship of Unit 14 relative to surrounding rocks has not yet been established in this area, these sandstones do lie along strike of known Rocky Harbour strata in the adjacent Glovertown area (O'Brien *et al.*, 1991a). Further mapping should demonstrate whether or not these units are coextensive.

Unnamed Redbed Division (Unit 15)

Unit 15 represents the red, clastic sedimentary component of the western belt of the Musgravetown Group. It is best exposed on the north shore of Clode Sound, west of Platter Cove. Extensive folding and faulting, coupled with significant gaps in exposure, preclude the establishment of its internal stratigraphy. Equivalent strata are also exposed around the southeast end of Pitts Pond. There, the sandstones lie within the thermal aureole of the Terra Nova Granite and have been metamorphosed to cordierite hornfels.

Fine- to coarse-grained red, maroon and, more rarely, purple sandstones typify this unit. These are locally intercalated with pale red, immature quartz-arenite. The widespread occurrence of detrital muscovite is a distinctive feature of the red sandstones. These rocks are interstratified on differing scales with red shale and siltstone, and in many cases contain shaley rip-ups. Other internal features include low amplitude, trough-crossbeds and ripple marks. Thickness and continuity of bedding are variable; locally, beds are extensively convoluted. Conglomerate is relatively rare in comparison to the eastern Musgravetown subbasin. Typically, rocks of Unit 15 are moderately to strongly cleaved and in some outcrops (e.g., near the Salmon Brook fault), are schistose and phyllitic. The unit is intruded by rare, coarse-grained (up to 8 cm), plagioclase–porphyritic mafic dykes.

The eastern boundary Unit 15 is unexposed, but is inferred to be coincident with the Platter Cove Fault of Jenness (1963). The unit's western boundary is the Salmon Brook Fault. The structure separates strongly cleaved to schistose red sandstone and granule conglomerate from sheared, metavolanic rocks. Tectonic fabrics in rocks on either side of the boundary are gently to moderately northwest-dipping. In some areas, (e.g., Northwest River) the boundary is the site of diabase dyke intrusion.

Widmer (1949) did not include the red beds, assigned here to Unit 15, in his Musgravetown Formation (Musgravetown Group of later workers). He instead named them 'Tabby Cat Cove Formation'. Jenness (1963), however, assigned these same rocks to the Musgravetown Group, correlating them with the red beds exposed east of the Charlottetown Fault. Hussey (1979) included the red beds in question in the Love Cove Group, and named them 'Southwest River formation'.

Hussey's assignment of these rocks to the Love Cove Group was based primarily on two points. The first was the interpretation of the boundary of these red beds with the westerly adjacent volcanic rocks (Jenness's western belt of the Love Cove Group; Unit 13 of this report) as a conformable contact, where red beds overie volcanic rocks. The second point was the correlation of those volcanic rocks with what Jenness had mapped as the eastern belt of the Love Cove Group. Hussey (1979) assumed that all rocks west of the Charlottetown Fault were part of the same regional stratigraphic package, which, along strike to the northeast passed conformably upward into latest Precambrian and possibly Cambrian strata.

Availiable data from this study supports Reusch and O'Driscoll's (1987) view that the aforementioned boundary is tectonic. Nevertheless, data collected along strike to the northwest in the Glovertown map area (see Holdsworth, 1991 and O'Brien and Holdsworth, 1992) indicates that volcanic and sedimentary units juxtaposed along the Salmon Brook Fault in that area are broadly coeval and synchronous with latest Precambrian, 'Musgravetown-aged' (cf. Jenness, 1963 and McCartney, 1967) rocks. These data corroborate, in part, Hussey's interpretation of the stratigraphy west of the Platter Cove Fault. However, the relation of these rocks to the volcanic succession east of the Platter Cove Fault, herein assigned to the Love Cove Group (Unit 1), is uncertain. On the basis of regional considerations outlined below (see Tectonic History) and until more data become available, the Love Cove Group is viewed as part of a volcanic assemblage that contains rocks significantly older than the Musgravetown Group.

POST-MUSGRAVETOWN GROUP INTRUSIONS

Unnamed Gabbro and Diorite (Unit 16)

At least two mafic plutonic stocks of mappable scale intrude the Musgravetown Group. A small, isolated body of fine-grained diorite intrudes red conglomerate approximately 3 km east-southeast of Bunyan's Cove. A more extensive body of medium- to coarse-grained gabbro is exposed on the north shore north of the Brooklyn peninsula and on several nearby islands in Goose Bay. The gabbro contains rare, fine-grained, pegmatitic patches and locally exhibits an irregularly developed, oikocrystic or patchy texture.

Terra Nova Granite (Unit 17)

The Terra Nova Granite (Strong *et al.*, 1974) is a chiefly undeformed, pink to buff, K-feldspar porphyritic granite that has intruded the Musgravetown Group in the northwestern part of the study area. The granite is typically medium to coarse-grained and porphyritic (Plate 9). Lesser amounts of subporphyritic, fine- to coarse-grained equigranular, and fine-grained quartz porphyritic variants are also present. The K-feldspar forms euhedral phenocrysts, mainly between 2 and 4 cm length; these locally display well-preserved rapikivi texture. K-feldspars up to 6 cm long were noted in places, but these are rare. The granite is quartz-rich; individual subhedral quartz crystals are 1 cm in diameter, on average. Small, rounded, cognate mafic xenoliths occur in a few localities. Rose, pink- and white-weathering aplite dykes, up to 10 cm width, are also present.

Emplacement of the Terra Nova Granite postdates the inhomogeneous regional deformation of the western belt of the Musgravetown Group. Its boundaries, however, are locally offset by late brittle faults. The granite is typically massive and unaltered but a weak fracture cleavage is developed in places. In the latter cases, altered feldspars and chloritized biotite were noted.

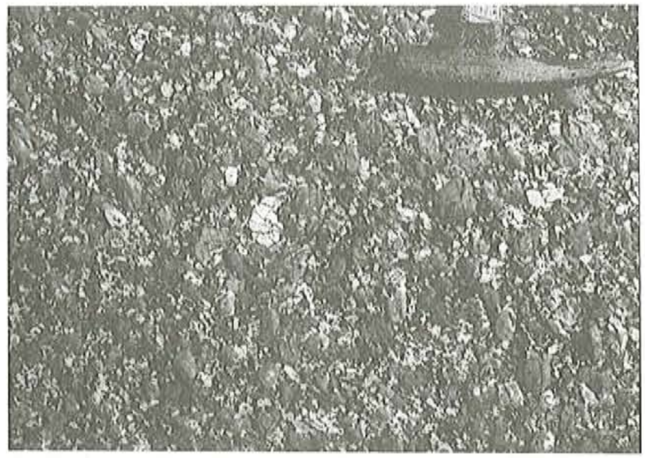


Plate 9. *K-feldspar porphyritic granite, Terra Nova Granite (Unit 17), Pitts Pond.*

The Terra Nova Granite is one of a suite of lithologically similar, posttectonic granites that are sited near or straddle the Gander–Avalon zone boundary in eastern Newfoundland (e.g., Ackley Granite, Newport Granite). Some have been dated isotopically and these are of Devonian age (e.g., Kontak *et al.*, 1988). The Terra Nova Granite is assumed to be genetically related to and broadly coeval with such intrusions, and on these grounds is provisionally assigned a Devonian age.

TECTONIC HISTORY

STRUCTURAL STYLES AND METAMORPHIC GRADES

The Precambrian rocks of the map area display a marked variation in style of deformation and grade of metamorphism. Most regional deformation of these rocks was complete prior to the emplacement of the Terra Nova Granite, presumably in the Devonian. Although some aspects of their tectonic history are also thought to be recorded in Cambrian strata, immediately south of the study area (Jenness, 1963), the angular unconformity at the base of the Musgravetown Group, coupled with the nature of metamorphic detritus within that group, implies that some deformation and metamorphism must have occurred in the Precambrian (prior to Musgravetown deposition). Both episodes of deformation are markedly inhomogeneous.

Love Cove Group

These rocks have everywhere been extensively affected by moderate to locally high-strain ductile deformation, and accompanying chlorite- to biotite-grade regional metamorphism. Coarse-grained to pegmatitic quartz–chlorite–potash feldspar veins of metamorphic origin are common throughout the volcanic parts of the Love Cove Group.

The first-generation fabrics in these rocks are axial planar to north- northeast- through north-northwest-trending, variably plunging isoclines. Examples of these tight, outcrop-scale folds are preserved in several locations, mainly in Unit 2 metasedimentary rocks. They are most likely parasitic on a series of larger map-scale structures (see Figure 3). As a general rule, the highest strain fabrics are more extensively developed in felsic to intermediate flows and pyroclastic rocks rather than in spatially associated mafic volcanic and tuffaceous rocks. Second-generation folds and fabrics are common. F2 folds plunge gently to the north or south; axial planes vary from vertical to moderately east-dipping (Plate 10). Wavelengths of F2 folds are generally less than 1 m.

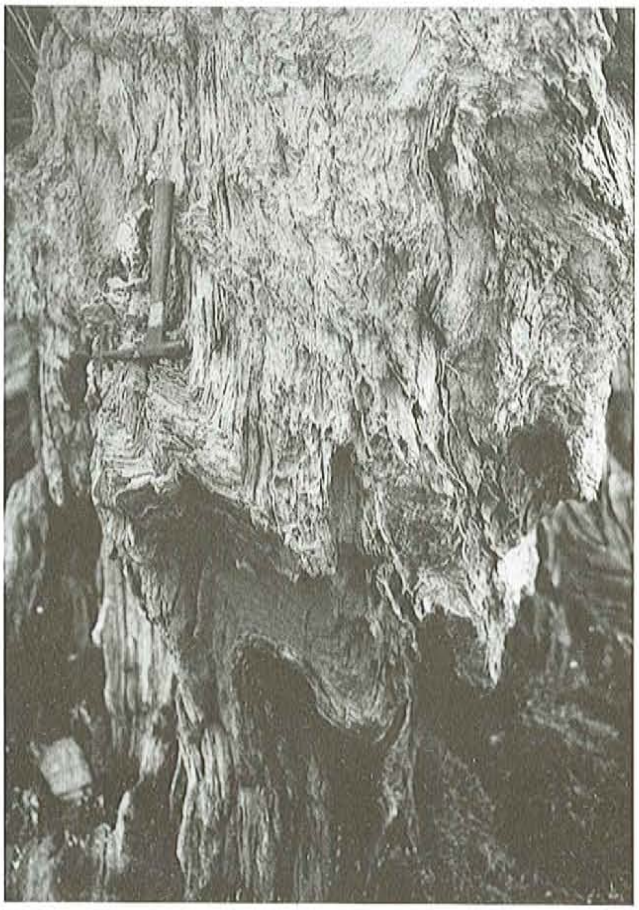


Plate 10. *Gently plunging, second-generation folds of a high-strain, ductile fabric in Love Cove Group metavolcanic rocks (Unit 1), Clode Sound.*

In the eastern quarter of the Love Cove belt (from a point approximately 1 km east of Love Cove, eastward to the Charlottetown Fault), the regional ductile fabric contains a strong, vertical to steep north- or south-plunging mineral lineation. West of this point, lineations are subhorizontal, and plunge very gently to the north and south. In the western part of the region of shallowly plunging lineation, asymmetric wrapping of clasts locally indicates a sinistral sense of shear. A consistent sense of displacement in the eastern part of the belt is yet to be documented. The boundary between zones of vertical and shallow lineations is a brittle fault. Near this boundary, two generations of lineations are present, and the shallower one overprints the steeper one. The nature and significance of the lineation switch, and the number and age of regionally developed lineations remain uncertain and will be investigated further in 1993.

Connecting Point Group

In terms of overall structural style, the Connecting Point succession varies from steep and upright, to slightly inverted, to moderately south- or southwest-dipping and homoclinal. The rocks are generally more phyllitic north of the Clode Sound Fault. Outcrop-scale tectonic folds are most common in the Connecting Point Group near the edge of the adjacent Musgravetown subbasin. These are moderate to tight, upright anticline-syncline pairs. The folds are north-northeast-trending, and subhorizontal to gently south-plunging. Fold wavelengths are typically between 1 and 5 m. An axial-plane cleavage is variably developed. A second-generation fabric is locally developed (e.g., adjacent to the basal beds of the Musgravetown Group at Bread Cove). Locally, the succession is extensively faulted. Particularly common are east–west- and northwest-trending crossfaults, which appear to have served as the site of diabase dyke emplacement.

On a regional scale, rocks of the Connecting Point Group become progressively younger to the southeast, toward the unconformable contact with the overlying Musgravetown Group. This contrasts with the situation farther north, in the Eastport and St. Brendan's map areas (O'Brien, 1987; O'Brien and Knight, 1988), where the succession is overturned and youngs to the northeast and east, away from the nearest belt of Musgravetown Group rocks. This variation is consistent with the large-scale folding of the Connecting Point Group prior to Musgravetown Group deposition. The relationship of this folding to the Love Cove Group tectonism is unknown, but it is likely that both are related to the same inhomogeneous deformational event (see below).

Musgravetown Group

The structural character of the Musgravetown Group is variable. Over large areas, the group is only mildly deformed and, in many places, cleavage has not been developed. Metamorphic grade is prehnite–pumpellyite in the eastern belt (Hussey, 1979), where the rocks are in contact with the more pervasively tectonized Love Cove and Connecting Point groups. Regional metamorphic grade increases to chlorite in the western belt.

In the clastic sedimentary part of the western Musgravetown belt, the degree of deformation increases with proximity to the Salmon Brook Fault. The redbeds are deformed by upright folds in the east, whereas farther west, overturned, east-verging, anticline-syncline pairs are common. The latter are truncated by outcrop-scale, east-directed thrust faults. Texturally, the volcanic rocks in the western belt vary from phyllonites and schists to moderately cleaved metavolcanic rocks and, locally, to weakly cleaved and fractured volcanic rocks, in which primary textures are well preserved.

Precambrian Granite

These rocks are less deformed than the adjacent Love Cove Group. The granite forms very small stocks, so competency contrast alone would not appear to explain the differing intensities of deformation. It is possible that its emplacement age may provide a younger limit to earliest deformation of the Love Cove Group. This granite superficially resembles the granite clasts in the Musgravetown Group.

Terra Nova Granite

Most of the regional deformation of the Precambrian rocks was complete prior to the emplacement of the Terra Nova Granite. Brittle faulting of Devonian and possible younger age has locally affected this pluton, offsetting its boundaries. The granite appears to be characteristically massive away from its contacts. Narrow zones of fracturing are very rarely developed and, adjacent to these features, biotite is altered to chlorite, and K-feldspar is cloudy. Cordierite appears to mimetically overgrow fabrics in country rocks adjacent to the pluton; this is yet to be confirmed petrographically.

TIMING OF TECTONISM OF THE LOVE COVE AND ADJACENT GROUPS

The stratified rocks of the study area are inferred to be late (post-640 Ma) Precambrian in age, based either on correlations with dated rocks or on published relationships described from adjacent or nearby map areas. Most of the deformation of the stratified succession was complete prior to the Devonian (?) emplacement of the Terra Nova Granite.

Rocks assigned to the Love Cove Group in this report represent the along-strike extension of a metavolcanic belt that includes rocks that are conformably overlain by the Connecting Point Group. North of the present study area, rocks from this same belt have been dated by G. Dunning at 620 $\pm$ 2 Ma (O'Brien *et al.*, 1992). The relationship of the Love Cove and Connecting Point groups—obscured in this area by the development of the eastern Musgravetown Group basin—coupled with the position of the Musgravetown Group unconformably above the Connecting Point Group, predicts that the Love Cove Group should lie unconformably beneath the Musgravetown Group. It follows then that the early deformation of the Love Cove Group, as well as a significant part of the tectonism affecting the Connecting Point Group, must predate Musgravetown Group sedimentation. The dramatic structural contrast preserved across the Love Cove Group—Musgravetown Group boundary at the Charlottetown Fault is consistent with this inference. In addition, the presence in the Musgravetown Group of detrital muscovite and clasts with pre-incorporation foliations (Plate 11) supports this scenario. The ductile nature of the fabrics in these clasts argues against previous views that the clasts were eroded from rocks deformed (near the surface) along active fault scarps (cf. Hussey, 1979).

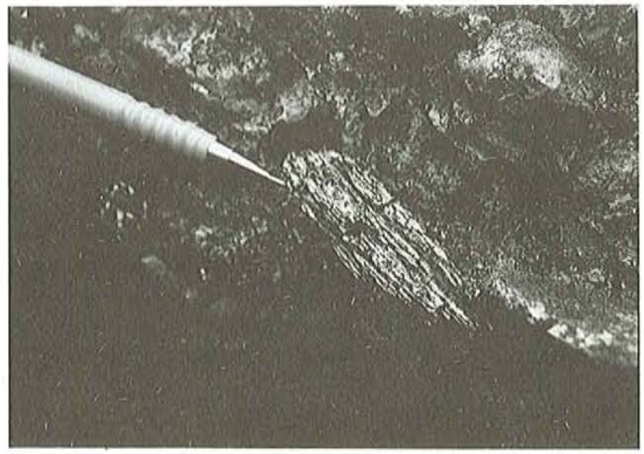


Plate 11. *Pre-incorporation, ductile foliation within metavolcanic clast in conglomerate (Unit 9) near the base of the Musgravetown Group at Bread Cove.*

However, not all rocks assigned to the Love Cove Group by previous workers necessarily represent the product of this pre-Connecting Point volcanism (see above). For example, the western belt of volcanic rocks, previously included in the Love Cove Group by Jenness (1963), is here interpreted to include, in whole or in part, volcanic rocks that are broadly coeval with Musgravetown Group deposition. This view corroborates Hussey's (1979) earlier interpretation of this belt. The latest ductile deformation of these rocks is of Paleozoic rather than Precambrian age and appears to be related to ductile movements along the Gander—Avalon zone boundary (e.g., Holdsworth, 1991; O'Brien and Holdsworth, 1992; O'Brien *et al.*, 1991b), which is located immediately northwest of the study area.

The main deformational event affecting the late Precambrian rocks in the western Avalon Zone was previously thought to also affect Cambrian strata; tectonism was thought to be part of the Devonian Acadian orogeny (e.g., Dallmeyer *et al.*, 1983). It is not clear at this point, however, whether the main Paleozoic deformation of the Precambrian rocks is of Silurian or Devonian age. The relationship of fabric development in the western Avalon Zone to major displacements along the Gander—Avalon zone boundary argues for a Silurian tectonism in the western Avalon Zone (O'Brien *et al.*, 1991b). The extent of Alleghenian (Carboniferous—Permian) deformation within the study area is unknown. Many of the latest brittle faults in the area could be of this age.

MINERALIZATION AND EXPLORATION POTENTIAL

In several areas (Figure 3), the Love Cove Group is host 3- to 5-m-wide zones of rusty sericite schist. These zones contain a variety of subparallel, millimetre- and centimetre-scale quartz veins, which carry disseminated pyrite. The veins contain slightly elevated gold concentrations, between 30 and 70 ppb. These zones occur in all of the lithofacies within the group and likely represent structurally controlled alteration along zones of strong ductile shearing.

It is significant that the rocks containing this alteration represent the northern continuation of the volcanic belt in which the Hickeys Pond and related gold prospects (Huard and O'Driscoll, 1986) are located. In these latter occurrences, which are situated on the northern Burin Peninsula, gold mineralization is spatially associated with shear zones adjacent to Precambrian granites. The intrusions are similar to those found immediately south of the study area (e.g., George's Pond granite; Hussey, 1979). It follows, then, that Unit 1, in general, and its immediate extension into the south half of the Port Blandford NTS sheet, in particular, has significant exploration potential for gold.

The Connecting Point Group contains rusty, brecciated zones near its fault contact with the Musgravetown Group west of Jamestown. Examples of minor, rusty shale and fine-grained sandstone are found throughout the group, most commonly in association with brittle faults.

In several places along the south shore of Clode Sound, beginning at a point approximately 1 km east of Bunyan's Cove, the volcanic rocks (Unit 11) of the eastern Musgravetown Group subbasin host quartz–hematite–pyrite ± galena veinlets and contain extensive Fe–Mn alteration. Elevated concentration of Y (< 245 ppm), Nb (< 325 ppm) and Zr (< 4041 ppm) in these rhyolites have been reported by Hussey (1979).

Galena and sphalerite are extensively disseminated within calcite veins in a mafic dyke in red Musgravetown Group conglomerate on the shore of Goose Bay, southeast of Bloomfield (see Figure 3). Secondary copper minerals are also present. Veins vary from 1 cm to approximately 40 cm in width; veins and mineralization occur mainly in the dykes and much less extensively in the host redbeds.

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