GEOLOGY OF THE HARE BAY AREA, NORTHWESTERN BONAVISTA BAY

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INTRODUCTION

Geological mapping of the east half of the Gambo map sheet (2D/16) and that part of the St. Brendan's map sheet (2C/13) underlain by the Gander Zone was completed during the 1976 field season. A preliminary map on a scale of 1:50,000 will be published in the spring, 1977.

GENERAL GEOLOGY

The map area comprises three major geological elements: (1) the gneisses, granitoid rocks, and metasedimentary rocks of the Gander Zone; (2) the volcanic and sedimentary rocks of the Avalon zone; and (3) the Dover Fault.

The Gander Zone gneisses belong to the Bonavista Bay Gneiss Complex (Blackwood and Kennedy, 1975) and are part of a basement terrane. A variety of deformed and undeformed granitic rocks intrude the basement gneisses. Low grade metasedimentary rocks of the Gander Group form a cover sequence to the gneisses in the northwestern part of the map area.

The Avalon Zone volcanic rocks in this area are part of the Love Cove Group (Jenness, 1963). They are strongly deformed and in fault contact with the Musgravetown Group (Hayes, 1948), a much less deformed sequence of red and green sandstones and conglomerates.

The Dover Fault, a 300-500 m wide mylonite zone, forms the boundary between the Gander and Avalon zones.

GANDER ZONE

Bonavista Bay Gneiss Complex

The Bonavista Bay Gneiss Complex may be subdivided into two gneissic terranes: psammitic and semipelitic paragneisses of the Square Pond Gneiss; migmatitic and tonalitic orthogneisses of the Hare Bay Gneiss (Blackwood, 1976).

The Square Pond Gneiss (Unit 1) forms a continuous, northeast-trending, lithologic unit throughout the western portion of the map area. It is predominantly well banded, light grey psammitic gneiss. Locally the gneissic fabric is not developed in fine grained phyllitic zones (Trans-Canada Highway near Gambo) and poorly displayed in an area of low grade metasedimentary rocks (north-central portion of Square Pond Gneiss). Bedding and a clastic texture are preserved in the latter area, which occupies the core of a southwest-plunging antiform. On the south shore of Gull Pond there is a tongue of remobilized paragneiss with local pods of migmatite. All variations, including low grade paragneiss and high grade migmatites, are gradational with the major rock type, "pinstripe" psammitic gneiss. Locally, the Square Pond Gneiss increases from biotite to kyanite in metamorphic grade with proximity to the migmatite front separating the paragneisses and orthogneisses.

The Hare Bay Gneiss (Unit 2) forms a continuous belt east of, and in part adjacent to, the

paragneiss terrane. It consists of crudely to well banded tonalitic gneiss. Locally, it is distinctly migmatitic with no directed fabric. Throughout the migmatite gneiss there are rafts and xenoliths of paragneiss. The external gneissosity of the host forms augen around the gneissic enclaves. Towards the migmatite front, remobilization associated with migmatization becomes less pronounced, i.e., rafts of paragneiss become more profuse and concordant with the developing orthogneiss, indicating in situ migmatization. Locally, the tonalitic gneiss is granetiferous.

FOLIATED INTRUSIVE ROCKS

A variety of foliated intrusive rocks cut the Bonavista Bay Gneiss Complex. Most occur within the Hare Bay Gneiss but, since they postdate the structures in the migmatites, this spatial relationship is fortuitous rather than significant.

A small body of strongly foliated, biotite granite (Unit 3) outcrops on the south-central shore of Freshwater Bay. Locally, the granite has a gneissic foliation which passes gradationally into a single penetrative cataclastic fabric in which flattened quartz and oriented biotite form augen around crushed feldspars. Contacts with the Hare Bay Gneiss are not exposed.

The Lockers Bay Granite (Blackwood and Kennedy, 1975) (Unit 4) forms a continuous linear body throughout the eastern portion of the Gander Zone. It is characterized by ubiquitous microcline megacrysts which range from 4 to 8 cm in length. Quartz and biotite are generally oriented and form augen around the flattened megacrysts. The foliation is distinctly cataclastic and has a north-northeast trend with steep dips. Locally, narrow zones of moderately deformed to undeformed granite suggest a pattern of inhomogeneous deformation for this generally highly deformed body. The Lockers Bay Granite clearly intrudes the Hare Bay Gneiss and postdates structure in the migmatitic gneiss (south shore of Lockers Bay), but locally intrusive relationships are camouflaged by the autometasomatic development of feldspar porphyroblasts.

A medium grained, coarsely porphyritic biotite granite (Unit 5) intrudes the Hare Bay Gneiss west and southwest of Trinity. Generally, the feldspar megacrysts (pink and white) are "spottingly" distributed throughout the rock but locally, in the centre of the pluton, they are profusely developed. Both the rock texture and the size of the megacrysts (1-3 cm) distinquish this granite from the Lockers Bay. A pervasive, northeast-trending, moderately to steeply dipping foliation overprints the granite. Locally this fabric is cataclastic, expecially along the northwestern margin of the body.

Two small bodies of gabbro (Unit 6) intrude the Square Pond Gneiss at Gull Pond and Wing Pond. The gabbro is fine to medium grained and massive to strongly schistose. Where developed, the main foliation is northeast trending with moderate dips to the east and west. Locally, the foliation appears composite. The gabbro bodies also quite clearly postdate the gneissic banding in the paragneisses.

Two narrow, elongate bodies of garnetiferous granite (Unit 7) also outcrop in the map area. One intrudes the Hare Bay Gneiss west of Lockers Bay and the other intrudes the Square Pond Gneiss on the southwest shore of Freshwater Bay. These granites are characterized by small red garnets in a generally leucocratic host of white feldspar, quartz and mica. Locally, however, the garnetiferous granites have varying amounts of biotite, pink feldspar and tourmaline. A strong, penetrative foliation, which is locally transposed by a widely spaced strain-slip fabric, overprints the garnetiferous granites. In one locality, third phase (F_3) folds were observed.

The Dover Fault Granites (Blackwood, 1976) (Unit 8) form a narrow discontinuous belt

adjacent to the fault on the Gander Zone side. These granites are medium grained and approximately equigranular. Near the contacts with the Hare Bay Gneiss, a penetrative foliation is developed. This fabric is cataclastic and becomes mylonitic with proximity to the Dover Fault.

Northeast of Traverse Pond, a small body of fine to medium grained, muscovite granite (Unit 9) intrudes the Hare Bay Gneiss. Minor amounts of biotite are present with the quartz, muscovite and white feldspar. Locally, a penetrative foliation overprints the granite but in most exposures a weak mica alignment defines the fabric.

THE GANDER GROUP

The Gander Group (Kennedy and McGonigal, 1972; Blackwood and Kennedy, 1975) (Unit 10) underlies the northwest corner of the map area. It comprises greenish-grey psammites and interbedded quartz-greywacke horizons. The latter are coarse enough for a clastic texture to be discernable. One conglomerate horizon outcrops close to the contact with the Square Pond Gneiss. The conglomerate varies from red to greenish-grey in color and contains well rounded but poorly sorted clasts. Locally, it contains pebbles which have been foliated prior to inclusion in the conglomerate. Bedding is preserved in heterogeneous units but is not detectable in areas of homegeneous fine grained psammites. No reliable facing directions were found.

A north-northeast trending foliation overprints the Gander Group. West of the contact with the basement gneisses, the foliation has moderate to gentle westward dips; close to the contact the dips become steeper and locally dip to the east. The main fabric appears to be a second schistosity, with the first fabric parallel to bedding. The lack of good bedding-cleavage intersections and poor exposure make the recognition of large scale fold structures difficult.

POSTTECTONIC GRANITES

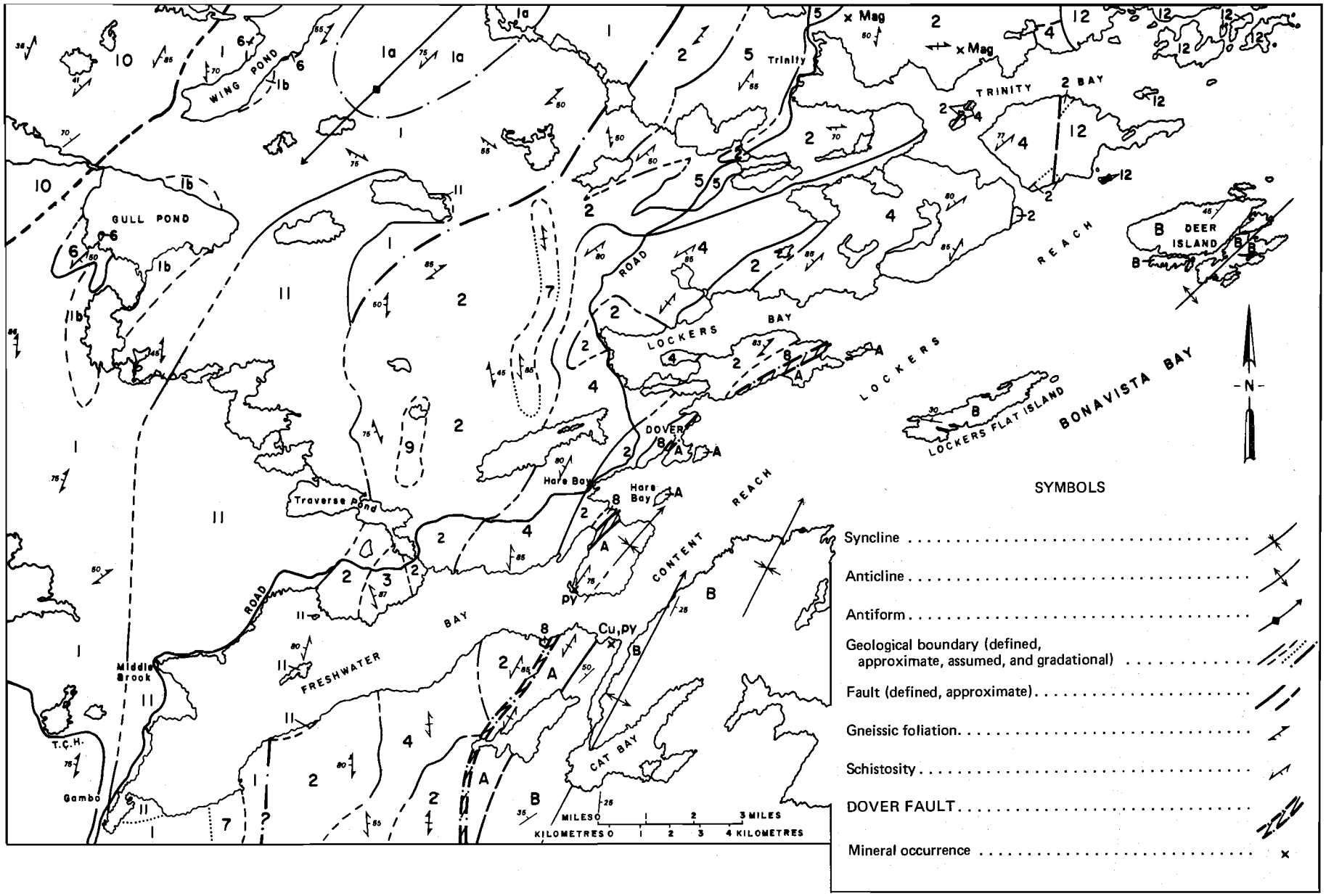
The Middle Brook Granite (Strong et al., 1974) (Unit 11), a coarse grained, porphyritic granite, is exposed along the northwest shore of Freshwater Bay; north of the bay it forms a narrow tongue projecting into the Square Pond Gneiss. Sharp contacts are exposed between the paragneisses and the granite; the latter has no foliation and clearly postdates all structures in the gneisses. Part of the eastern margin of the Middle Brook Granite follows the migmatite front between paragneisses and migmatites such that the bulk of the granite is in the paragneiss terrane. Locally, along the eastern margin of the granite body, a weak foliation is developed within a few metres of the contact. On two small islands in Freshwater Bay, granite tenatively included with the Middle Brook has a more intense fabric. For the most part, however, this granite is characterized by fresh quartz, disoriented biotite and feldspar megacrysts.

The Newport Granite (Strong et al., 1974) (Unit 12) underlies the extreme northeast corner of the map area. It is coarse grained, massive and porphyritic with stubby K-feldspar megacrysts. This granite clearly intrudes the Hare Bay Gneiss and the Lockers Bay Granite posttectonically.

AVALON ZONE

Love Cove Group

The Love Cove Group (Unit A) forms a continuous lithologic unit on the east side of the Dover Fault. It consists of a series of acidic pyroclastic rocks and flows with minor interbedded


WING POND
GULL POND
ROAD
TRINITY
TRINITY BAY
REACH
DEER ISLAND
LOCKERS BAY
LOCKERS
LOCKERS FLAT ISLAND
BONAVISTA BAY
DOVER
Hare Bay
Traverse Pond
CONTENT REACH
ROAD
FRESHWATER BAY
Middle Brook
T.C.H.
Gambo
CAT BAY
Cu,py
py
x Mag
MILES 0 1 2 3 MILES
KILOMETRES 0 1 2 3 4 KILOMETRES
N
SYMBOLS
Syncline
Anticline
Antiform
Geological boundary (defined, approximate, assumed, and gradational)
Fault (defined, approximate)
Gneissic foliation
Schistosity
DOVER FAULT
Mineral occurrence

LEGEND

GANDER ZONE

DEVONIAN OR EARLIER(?)

12 NEWPORT GRANITE: Massive, coarse grained, porphyritic granite.

11 MIDDLE BROOK GRANITE: Massive, coarse grained, porphyritic granite.

LOWER ORDOVOCIAN OR EARLIER

10 GANDER GROUP: Polydeformed metasedimentary rocks; psammites, semipelites, and minor conglomerate horizons

HADRYNIAN(?)

9 Foliated, fine to medium grained, muscovite granite.

8 DOVER FAULT GRANITES: Foliated (locally mylonitized) equigranular, medium grained granite.

7 Foliated, fine to medium grained, garnetiferous granite.

6 Foliated, medium to coarse grained, gabbro.

5 Foliated, "spottingly" porphyritic, biotite granite.

4 LOCKERS BAY GRANITE: Foliated megacrystic, microcline granite.

3 Foliated (locally gneissic) medium grained, biotite granite.

HELIKIAN(?)

BONAVISTA BAY GNEISS COMPLEX

2 HARE BAY GNEISS: Tonalitic orthogneiss containing enclaves of paragneiss.

1 SQUARE POND GNEISS: Psammitic and semipelitic paragneiss; 1a - Non-gneissic meta-psammites and semipelites; 1b - Partially migmatized paragneiss, including granite gneiss.

AVALON ZONE

LATE HADRYNIAN - EARLY CAMBRIAN

B MUSGRAVETOWN GROUP: Red and green sandstones and conglomerates; locally developed slaty cleavage.

HADRYNIAN

A LOVE COVE GROUP: Foliated (locally mylonitized) acidic volcanic flows and volcanigenic sedimentary rocks.

sedimentary rocks. Locally, mafic volcanic rocks are also present. A strong, north-northeast trending, steeply dipping, foliation overprints the Love Cove Group. With proximity to the Dover Fault this fabric becomes cataclastic. Northeast plunging, isoclinal folds and low greenschist metamorphism are associated with this deformation.

MUSGRAVETOWN GROUP

The Musgravetown Group (Unit B) underlies the southeastern part of the map area, including Lockers Flat Island and Deer Island. The group comprises red and green sandstones, red conglomerates, and minor interbedded shales. A slaty cleavage overprints the Musgravetown Group and is axial planar to open folds with moderate northeast plunges. A high-angle fault separates the Love Cove and Musgravetown Groups.

STRUCTURAL GEOLOGY

Regional Foliation

A north to northeast trending, generally steeply dipping, foliation is regionally developed in the Gander and Avalon Zones. It overprints older gneissic structures in the Bonavista Bay Gneiss Complex and is developed as a single penetrative foliation in the deformed intrusive rocks. Locally, this fabric has a cataclastic component and towards the southeast it merges with mylonites of the Dover Fault Zone. (The first foliation (S_1) of the Gander Group may be related to the regional fabric).

The Love Cove Group of the Avalon Zone is overprinted by the regional foliation, which locally is strongly cataclastic. To the northwest this fabric merges with mylonites of the Dover Fault Zone.

The Dover Fault, a 300-500 m wide mylonite zone, marks the boundary between the Gander and Avalon Zones. Within the fault zone rocks range from protomylonites to ultramylonites. The mylonites formed in association with the regional foliation.

Earlier Structures

Gneissic rocks of the Bonavista Bay Gneiss Complex record a variety of earlier structures. Both the paragneisses and the orthogneisses display a pronounced gneissic banding that evolved as the result of regional metamorphism and transposition. Later refolds are also evident, producing complex interference patterns.

Later Structures

The main foliation of the Gander Group is interpreted as a second phase structure (S_2). It is axial planar to large scale recumbent folds which overturn to the southeast. Towards the contact with the Square Pond Gneiss some tectonic flattening is associated with this deformation. Locally the gneisses are overprinted by a similar fabric close to the basement-cover contact.

A strain-slip fabric locally overprints the regional (cataclastic) foliation. This is best seen on the margins of the larger intrusive rocks (e.g. Lockers Bay Granite) and within the smaller garnetiferous granite bodies. In at least two localities this fabric is folded by moderately tight folds.

Narrow, gently dipping shear zones crosscut the regional fabric in some foliated granitic rocks.

A strain-slip fabric is locally developed in previously deformed volcanic rocks of the Love Cove Group. No major folding is associated with this deformation, which may also be represented by small crenulations.

The slaty cleavage of the Musgravetown Group is presently interpreted as later than the regional foliation common to both the Gander and Avalon Zones. In some massive sandstone and conglomerate horizons, the cleavage is represented by widely spaced fractures. This fabric is axial planar to open, moderately plunging folds.

A high-angle, northeast trending fault separates the Love Cove and Musgravetown Groups with minor fractures occurring in the fault zone. Presumably there is downthrow, to the southeast, of the area underlain by the Musgravetown Group.

MINERALIZATION

A few minor mineral showings were found in the map area. Chalcopyrite and pyrite occur with quartz and chlorite in sigmoidal tension gashes within sandstones of the Musgravetown Group on the southwest shore of Content Reach. Malachite covers joint surfaces at this locality. Magnetite occurs as disseminated medium-size grains and as small pods (1 cm in diameter) in gneissic migmatites on the north shore of Trinity Bay. A narrow rusty zone (pyrite) occurs in Love Cove volcanic rocks on the southwest corner of the peninsula east of Hare Bay.

SUMMARY AND CONCLUSIONS

The Gander is underlain by basement gneisses (Bonavista Bay Gneiss Complex) in which a migmatite front separates older paragneisses (Square Pond Gneiss) to the west from younger migmatites (Hare Bay Gneiss) to the east. A variety of foliated (e.g. Lockers Bay Granite) and undeformed (e.g. Middle Brook Granite) intrusive rocks cut the gneissic terrane. In the northwest, weakly metamorphosed but polydeformed metasedimentary rocks (Gander Group) form a cover sequence to the basement complex.

The Avalon Zone is underlain by intensely deformed metavolcanic rocks (Love Cove Group) of Hadrynian Age (Jenness, 1963) and much less deformed red and green sedimentary rocks (Musgravetown Group) of Late Hadrynian-Early Cambrian age (Hayes, 1948).

A major mylonite zone (Dover Fault) marks the boundary between the Gander and Avalon Zones. It probably formed during jutaposing of the two zones in the Precambrian (Blackwood, 1976). Hence, rocks affected by the regional cataclastic fabric in the Gander Zone are considered to be Hadrynian or older (the gneisses record an earlier complex history of metamorphism and deformation and may be of Helikian age).

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