THE GANDER ZONE AND ITS RELATIONSHIPS WITH THE AVALON AND DUNNAGE ZONES, NORTHEASTERN NEWFOUNDLAND

Field Trip Introduction

by

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GANDER ZONE

The Gander Zone (Williams et al., 1974) forms a linear crystalline zone along the southeastern margin of the Appalachian Orogen in Newfoundland. In northeastern Newfoundland it is underlain, from west to east, by polydeformed metasedimentary rocks, paragneisses and migmatites known as the Gander Group (McGonigal, 1973), the Square Pond Gneiss (Blackwood, 1976, 1977) and the Hare Bay Gneiss (Blackwood, 1976) respectively. These three metamorphic belts are interpreted to represent a conformable sequence which underwent prograde metamorphism from west to east (Jenness, 1963; Blackwood, 1978). A variety of foliated and undeformed plutonic rocks (mostly granitoid) is intrusive into the metamorphic units.

Gander Group

The Lower Ordovician or earlier Gander Group consists of interbedded psammite, feldspathic quartzite, semipelite, minor pelite and minor mafic tuff. Greenish-grey psammite and feldspathic quartzite are the predominant rock types. A fine foliation is locally developed parallel to bedding; the main fabric is a composite schistosity that transposes this earlier bedding parallel foliation. The widely spaced second schistosity is axial planar to

recumbent isoclinal folds in the west (flat belt) and gradually steepens eastwards where upright folds are developed (steep belt). The Gander Group was deformed during greenschist facies metamorphism in this area.

Square Pond Gneiss

The Square Pond Gneiss consists of psammitic and semipelitic paragneiss with minor zones of schist and migmatite. A "pinstripe" banding, defined by the regular alternation of quartzofeldspathic bands and biotite rich bands, is characteristic of the paragneiss. Transposition during metamorphism produced this regular gneissosity; there is a gradation between the initiation of folds in banded paragneiss to complete transposition and development of a new foliation. Locally, primary layering is preserved in the Square Pond Gneiss. The metamorphic grade varies from greenschist to upper amphibolite facies. The contact between the Square Pond Gneiss and the Gander Group is gradational, marked by an abrupt increase in metamorphic grade. It is defined approximately at the biotite isograd in this region.

Hare Bay Gneiss

The Hare Bay Gneiss consists of biotite-rich migmatite and tonalitic gneiss, containing xenoliths and rafts of paragneiss. Banding is generally crudely developed; individual bands of leucosome and melanosome are discontinuous and marked by diffuse margins. Paragneiss inclusions are common and represent all rock types present in the Square Pond Gneiss. The smaller xenoliths contain variably oriented internal foliations and form augen in the external gneissosity of the tonalitic host. Complex interference patterns are

common throughout the Hare Bay Gneiss; the metamorphic grade is upper amphibolite facies. A migmatite front, defined by the formation of granite sweats, feldspathization, and lit-par-lit granite veining in the paragneiss protolith, separates the Square Pond and Hare Bay Gneisses.

Granitoid Rocks

Granitoid rocks intrusive into the Gander Zone may be subdivided into three broad categories based upon composition and relative age. The first group consists of coarse grained, megacrystic granites which form linear bodies that are restricted to the migmatites of the Hare Bay Gneiss, e.g. Lockers Bay and Cape Freels Granites. A strong, northeast trending fabric, commonly with a cataclastic component, overprints these granites and the country rocks. Locally, however, areas of weakly deformed to undeformed granite occur.

A second group comprises medium to coarse grained, locally porphyritic, two-mica leucocratic granites. Commonly, richly to sparsely garnetiferous phases are associated with these rocks, e.g. North Pond Granite. The leucocratic granites form linear to elongate bodies which intrude the major subdivisions of the Gander Zone including the foliated megacrystic granites. The granites range from massive to strongly schistose; in this region garnetiferous leucogranite aplites and pegmatites intrude the foliated megacrystic granites pretectonically.

A third group of granitoids consists of undeformed (except marginally), coarse grained megacrystic granites, e.g. Middle Brook and Deadman's Bay Granites. These large, massive plutons have crudely globular outlines which truncate the major structural and lithologic units of the country rocks.

AVALON ZONE

The Avalon Zone (Williams et al., 1974) is characterized by Precambrian volcanic and flyschoid rocks that are overlain by Late Hadrynian-Early Cambrian molasse sequences. These pass conformably, and locally unconformably, into Cambro-Ordovician platformal rocks.

Love Cove Group

The oldest rocks of the Avalon Zone in this region belong to the Precambrian Love Cove Group (Jenness, 1958). It consists of a series of acidic pyroclastic rocks and flows with minor interbedded sedimentary rocks. A strong, north-northeast trending foliation and associated low greenschist grade metamorphism overprint these volcanic rocks.

Musgravetown Group

The Late Hadrynian Musgravetown Group (Hayes, 1948) outcrops east of the Love Cove Group and the two are separated by a high angle fault. Red and green shale, sandstone and conglomerate are the common rock types of this little deformed and relatively unmetamorphosed sequence.

DOVER FAULT

The Dover Fault is a 300-500 m wide zone of cataclastic rocks which range from protomylonites to ultramylonites (Blackwood and Kennedy, 1975). The fault consistently marks the boundary between the Gander and Avalon Zones, separating the Love Cove Group in the east-southeast from granites and gneisses of the Gander Zone to the west-northwest. The cataclastic fabric associated with the Dover Fault is the only feature common to both the Gander and Avalon Zones in this area. It forms the regional penetrative foliation in

the Love Cove Group and overprints structures in the gneisses of the Gander Zone as well as some of the granitoid rocks. Major movement along the Dover Fault is interpreted as Acadian in age, associated with rapid uplift of the Gander Zone (Dallmeyer et al., 1981).

DUNNAGE ZONE

The Dunnage Zone (Williams, 1979) in this region is characterized by Ordovician slates and graywackes overlain by Silurian conglomerates, red beds and terrestrial volcanics. The Gander River Ultrabasic Belt (GRUB line) generally marks the boundary between the Gander and Dunnage Zones north of Gander Lake; south of the lake the GRUB line is discontinuous and the boundary between the two zones is marked by a conformable change in lithofacies (Blackwood, 1982).

Gander River Ultrabasic Belt

The Middle Ordovician or earlier Gander River Ultrabasic Belt (Jenness, 1958) forms a narrow linear zone west of, and structurally above, the Gander Group. It comprises pyroxenite, serpentinite, magnesite, gabbro, talc/tremolite zones, mafic flows and volcaniclastics, trondhjemite and quartz porphyry. Unaltered, coarse grained plutonic rocks are generally massive, otherwise a pronounced fabric, locally mylonitic, overprints GRUB line rocks. Regional metamorphism is low greenschist facies; higher grade contact metamorphism occurs locally. The contact between the GRUB line and the Gander Group is a low to high angle, west dipping fault.

Davidsville Group

The Middle Ordovician Davidsville Group (Kennedy & McGonigal, 1972), lies to the west of the GRUB line, except for small outliers and local infolded areas. It comprises conglomerate, sandstone, shale, siltstone, litharenite and minor limestone. These rocks are everywhere strongly cleaved and commonly polydeformed. The regional metamorphic grade is low greenschist except for local, higher grade, contact metamorphism. The Davidsville Group nonconformably overlies rocks of the GRUB line; the unconformity is marked by basal polymictic conglomerate. South of Gander Lake, where the GRUB line is not developed, slate and siltstone of the Davidsville Group are apparently conformable with semipelite and psammite of the Gander Group.

Botwood Group

The Silurian Botwood Group (Williams, 1962) underlies the western part of the area, west of the Davidsville Group. It comprises red and gray, locally micaceous, sandstone and shale, litharenite, minor fossiliferous limestone and calcareous sandstone, and minor conglomerate. A penetrative cleavage associated with low greenschist regional metamorphism affects the Botwood Group. The contact between the Botwood and Davidsville Groups is locally faulted but regionally appears to be gradational.

GAC FALL FIELD TRIP

DAY 1

CROSS-SECTION OF GANDER ZONE

AND BOUNDARY AREAS

STOP 1-1: GANDER GROUP - FLAT BELT

Interbedded psammite and phyllite are flat to gently dipping. The main phyllitic foliation is sub-parallel to bedding and 1 to 4 mm wide laminae. These rocks are disposed in large scale southeast facing F_2 recumbent folds and are of low greenschist metamorphic grade.

STOP 1-2: GANDER GROUP - STEEP BELT

Psammite and semipelite are steeply dipping in the aureole of the Gander Lake Granite. Biotite is developed on the main fabric planes, locally producing a very fine pinstripe banding. Cordierite and muscovite porphyroblasts occur locally. Although the increase in metamorphic grade is largely due to the Gander Lake Granite, it serves to show what the transition between the Gander Group and its higher grade equivalent, the Square Pond Gneiss, is like where increasing regional metamorphism has occurred.

STOP 1-3: SQUARE POND GNEISS

High grade (amphibolite facies) paragneiss is characterized by a regular "pinstripe" metamorphic banding, 1-4 mm wide. These rocks are psammitic to semipelitic in composition; cordierite and sillimanite occur in the more pelitic zones. Quartz and granitic "sweats" are developed parallel to the fine gneissosity. The metamorphic banding, developed by successive trans-

LEGEND

GANDER ZONE

DEVONIAN AND EARLIER

 *Undeformed megacrystic granites, e.g. Middle Brook, Deadman's Bay*

 *Foliated two-mica granites, e.g. North Pond, Middle Ridge*

 *Foliated megacrystic and minor equigranular granites, e.g. Lockers Bay, Cape Freels*

LOWER ORDOVICIAN OR EARLIER

 GANDER GROUP: *Psammite, semipelite and feldspathic quartzite*

 SQUARE POND GNEISS: *Psammitic and semipelitic paragneiss; minor schist and migmatite*

 HARE BAY GNEISS: *Migmatite with paragneiss inclusions*

AVALON ZONE

HADRYNIAN

 MUSGRAVETOWN GROUP: *Shale, sandstone and conglomerate*

 LOVE COVE GROUP: *Felsic volcanics and minor sedimentary rocks*

DUNNAGE ZONE

DEVONIAN OR EARLIER

 *Tonalite*

SILURIAN

 BOTWOOD GROUP: *Red and gray sandstone and shale; minor limestone*

MIDDLE ORDOVICIAN

 DAVIDSVILLE GROUP: *Thinly bedded siltstone and shale, thickly bedded graywacke, and minor conglomerate*

LOWER ORDOVICIAN OR EARLIER

 GANDER RIVER ULTRABASIC BELT: *Pyroxenite, serpentinite, magnesite, gabbro, basalt, volcaniclastics, trondhjemite and quartz-porphyry*

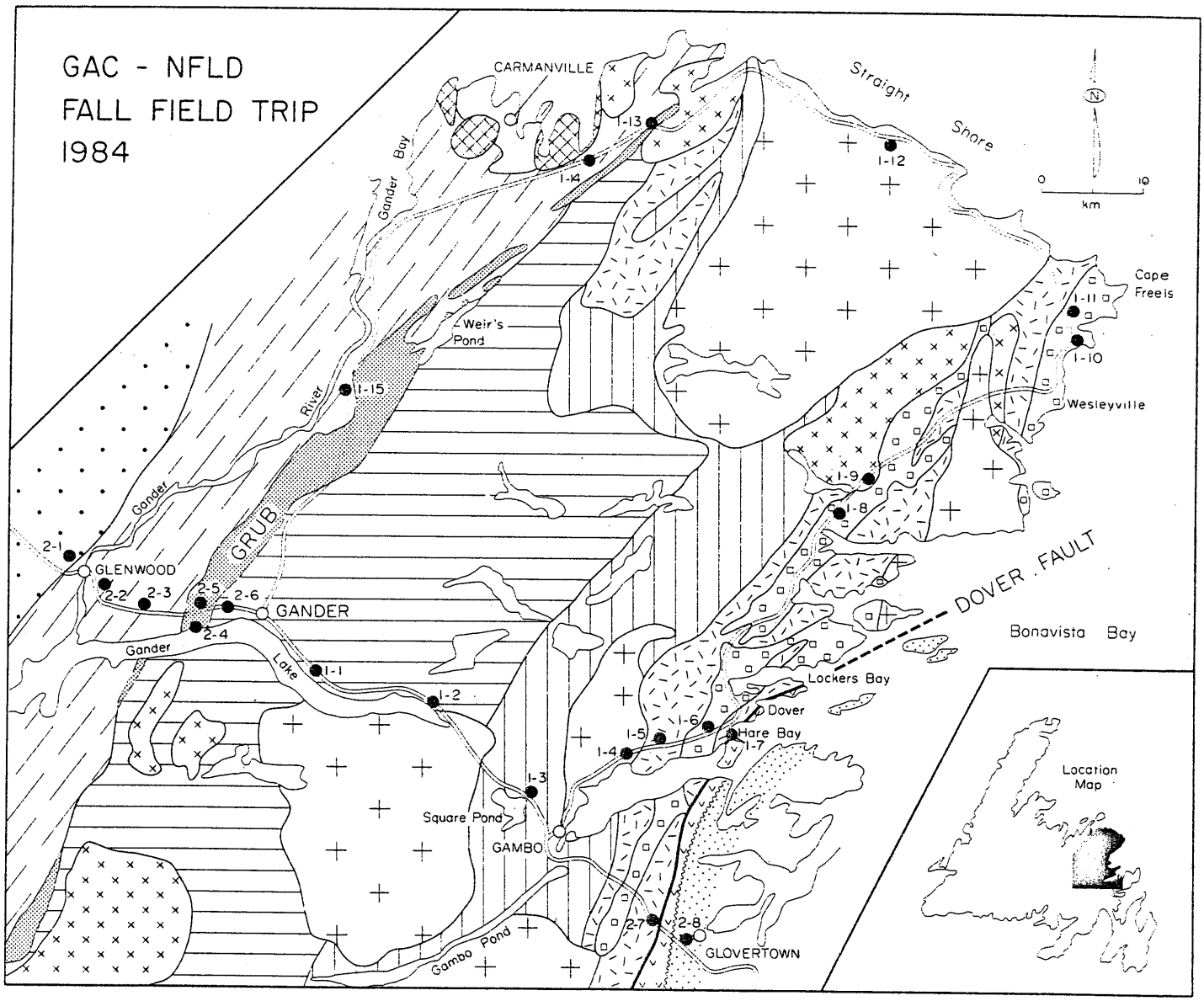

Figure 1: The Gander Zone - bounded by the GRUB line in the west and the Dover Fault in the east.

position, is clearly demonstrated in these exposures. Type 3 interference patterns are common. Garnetiferous, leucocratic granite veins postdate the banding in the paragneiss and are overprinted by a late penetrative foliation.

STOP 1-4: MIDDLE BROOK GRANITE

Undeformed megacrystic granite is characterized by stubby feldspar (plagioclase and orthoclase) megacrysts, 1-4 cm across. Distinctive blue quartz (caused by micro-inclusions) occurs in this part of the pluton. Biotite and coarse sphene are also well developed. The granite contains numerous paragneiss xenoliths.

STOP 1-5: HARE BAY GNEISS

A crude to well-developed banding marks this tonalitic migmatite. Psammitic and semipelitic paragneiss inclusions are common; banding in the tonalitic host wraps around these previously deformed inclusions. The migmatite is intruded by leucocratic granitic and pegmatitic dikes that are locally garnetiferous. The pegmatites commonly contain tourmaline. These dikes are overprinted by a strong, penetrative foliation that is axial planar to refolds of the gneissic banding.

STOP 1-6: LOCKERS BAY GRANITE

Megacrystic microcline granite is rich in biotite. Conspicuous microcline megacrysts are 1-8 cm long. An intense cataclastic fabric overprints the granite and is defined by oriented biotite, elongated quartz and crushed feldspar. "Tails" of crushed material commonly occur in the lee of the large feldspar crystals.

STOP 1-7: DOVER FAULT GRANITE, THE DOVER FAULT AND THE LOVE COVE GROUP

Pink feldspar, equigranular granite is medium to coarse grained. A penetrative, cataclastic fabric overprints the body and locally produces mylonite zones. Within these zones the granite is reduced to a green mylonite with a few feldspar porphyroclasts. The green colour is due to the concentration of chlorite and epidote in these severely crushed zones.

The Dover Fault granite grades from protomylonite (adjacent to the fault) to ultramylonite within the Dover Fault zone. Classic cataclastic textures are developed throughout. Within the fault zone postmylonite brecciation occurs, possibly related to tuffisite activity, e.g. mylonite fragments "float" in a chlorite-epidote rich matrix. Later movement along the fault has also produced drag folds of the mylonitic banding. The central part of the fault zone is underlain by beach and bog in this area.

The Love Cove Group outcrops east of the beach and consists of medium grained crystal-lithic tuff, interbedded with fine grained green tuffaceous layers. Flattened, epidote-rich patches are interepreted to represent bombs. A pronounced cataclastic fabric overprints these volcanic rocks; generally this deformation destroys most primary textures. Elsewhere the fabric in the Love Cove Group can be seen to merge with mylonites of the Dover Fault zone.

STOP 1-8: WAREHAM GRANITE: PEGMATITE/VEIN

Feldspar porphyritic biotite granite contains a raft of semipelitic schist and migmatite. The granite is variably foliated and intruded pretectonically by a garnet-tourmaline-muscovite-beryl bearing pegmatite.

STOP 1-9: NORTH POND GRANITE

Medium grained, equigranular to porphyritic, two-mica granite is locally garnetiferous with a moderately developed foliation. It also contains 0.5 to 2 cm long oriented clots of biotite ± muscovite.

STOP 1-10: CAPE FREELS GRANITE

Relatively unfoliated K-feldspar megacrystic biotite granite.

STOP 1-11: CAPE FREELS GRANITE

Intensely foliated megacrystic granite. Feldspars with crushed tails are wrapped around by oriented biotite and flattened quartz.

STOP 1-12: DEADMAN'S BAY GRANITE

Massive, feldspar megacrystic, biotite granite.

STOP 1-13: GRUB LINE

Massive to strongly sheared serpentinite. Contains veins and lenses of carbonate; talc is developed in local shear zones.

STOP 1-14: DAVIDSVILLE GROUP

Black slates. Thin sandy beds are locally transposed along stongly developed cleavage planes. Tiny andalusite(?) porphyroblasts reflect proximity of the Rocky Bottom pluton.

STOP 1-15: DAVIDSVILLE GROUP

Polymictic, matrix supported, conglomerate containing clasts of trondhjemite, felsite, fine to coarse grained gabbro, jasper, carbonate, serpentinite, red and green siltstone, epidote and quartz. Most clasts are pebble size but cobbles and small boulders also occur; the largest and most profuse clasts are trondhjemite. These rocks occur in the west limb of a syncline that infolds the Davidsville Group with the GRUB line; the associated cleavage is well developed in the conglomerate matrix.

DAY 2

DUNNAGE-GANDER ZONE AND GANDER-AVALON ZONE BOUNDARY AREAS

STOP 2-1: BOTWOOD GROUP

Fine grained, red, micaceous sandstone with intercalated limestone lenses are steeply dipping. Brachiopods occur in the sandstone; the limestone is rich in crinoid stems and corals (?).

STOP 2-2: DAVIDSVILLE GROUP

Grayish black, coarse grained, litharenite is interbedded with black siltstone. Poorly sorted, subrounded to angular clasts of feldspar, volcanic quartz and rock fragments occur in a muddy matrix. These form part of the proximal turbidites of the upper Davidsville Group.

LEGEND

DEVONIAN (?)


Pink granite (Mount Peyton)


Megacrystic granite


Two-mica leucogranite

SILURIAN

BOTWOOD GROUP


Red and gray sandstone and shale; minor limestone

MIDDLE ORDOVICIAN

DAVIDSVILLE GROUP


Thickly bedded graywacke with interbedded siltstone


Thinly bedded siltstone and shale


Polymictic conglomerate and sandstone

LOWER ORDOVICIAN OR EARLIER

GANDER GROUP


Psammite, semipelite and feldspathic quartzite

GANDER RIVER ULTRABASIC BELT (GRUB)


Trondhjemite and quartz-porphyry


Pillowed basalt and volcaniclastics


Gabbro


Pyroxenite, serpentinite and magnesite

SYMBOLS

Geological contact (defined, approximate, gradational) . . . . . 

Anticline . . . . . 

Syncline . . . . . 

Fault (approximate) . . . . . 

Thrust fault (approximate, assumed) . . . . . 

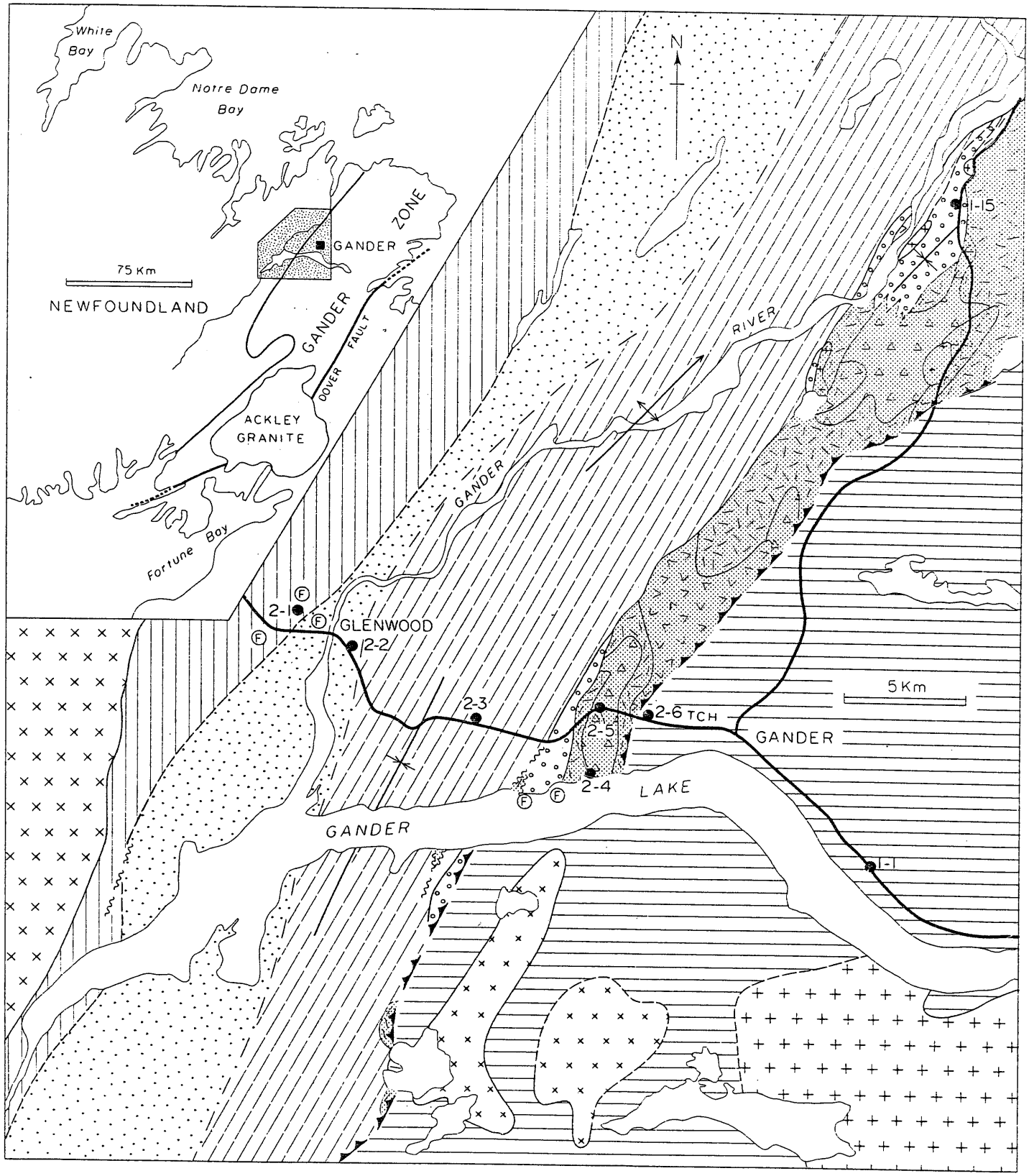

Figure 2: The GRUB line, boundary area of the Gander and Dunnage Zones.

STOP 2-3: DAVIDSVILLE GROUP

Thinly bedded siltstones and mudstones (distal turbidites) are overprinted by a strong slaty cleavage. The cleavage is axial planar to tight, upright folds. Bedding/cleavage intersection indicates that these rocks are on the east limb of an anticline. Open kinks postdate the main fabric.

STOP 2-4: NONCONFORMITY BETWEEN THE DAVIDSVILLE GROUP AND THE GRUB LINE

Polymictic, medium to coarse grained conglomerate lies nonconformably upon serpentinized pyroxenite. The conglomerate contains trondhjemite, pyroxenite, gabbro, serpentinite and sedimentary clasts.

STOP 2-5: DAVIDSVILLE GROUP - OUTLIER ON THE GRUB LINE

Medium to coarse grained sandstone consists of generally well rounded quartz and feldspar clasts. Angular quartz-feldspar porphyry clasts occur in isolation, suspended by matrix, or form minor conglomerate lenses. Rare, bright green, fuchsite bearing clasts also occur.

STOP 2-6: GANDER GROUP

Thickly bedded feldspathic quartzite and psammite with minor pelitic material. These rocks are structurally below the GRUB line and contain large scale recumbent folds. A fine fabric is parallel to laminations in the psammite suggesting that the main cleavage, axial planar to these folds, is S_2.

STOP 2-7: HARE BAY GNEISS, GANDER ZONE

Reworked, crudely banded, tonalitic migmatite adjacent to the Dover Fault. Pelitic and psammitic inclusions occur locally; porphyroblastic plagioclase is profuse in the more pelitic zones. Discontinuous quartz and granitoid sweats are common. The migmatite is intruded by granitoid dikes which show the strong cataclastic foliation associated with the Dover Fault, e.g. quartz augen and streaked feldspar occur in the overprinting fabric planes.

STOP 2-8: MUSGRAVETOWN GROUP, NORTHWESTERN AVALON ZONE

Sandstone and interbedded siltstone - typical examples of Musgravetown Group clastics. A coarse fracture cleavage is locally developed; these rocks are relatively unmetamorphosed.

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