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A MAJOR DUCTILE SHEAR ZONE IN THE BAY D'ESPOIR AREA, GANDER TERRANE, SOUTHEASTERN NEWFOUNDLAND

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ABSTRACT

In the region of Bay d'Espoir, the volcanic–sedimentary Baie d'Espoir Group is interpreted as an allochthonous sheet. It is separated from the Little Passage Gneiss, an assemblage of schists and migmatites of the Gander Terrane, by a major zone of layer-parallel ductile shearing, locally 12 km wide.

Mylonites in the shear zone contain abundant kinematic indicators and a regionally penetrative stretching lineation, which is subhorizontal and trends west-southwest. In gently inclined rocks far removed from the Hermitage Bay Fault zone, mylonitic fabrics indicate that the shear zone is a gently inclined thrust ('strike-slip thrust') along which the Baie d'Espoir Group has been transported over the Little Passage Gneiss toward the west-southwest. Near the Hermitage Bay Fault zone, the foliations in the rocks steepen, and the layer-parallel shear zone becomes a steep zone of sinistral strike-slip (transcurrent) movement. The steepening is associated with a regional increase in metamorphic grade and extensive granitic magmatism, interpreted as accompanying and overlapping the shearing movements.

The shear zone in Bay d'Espoir closely resembles the shear zone described by Hanmer (1981) from the northeastern Gander Terrane. It is suggested that the Bay d'Espoir shear zone may be a segment of a major shear zone on which allochthonous sheets of rocks of Dunnage affinity (Baie d'Espoir, Davidsville groups) have moved over the Gander Terrane in a southwesterly direction, a direction parallel with the trend of the orogen.

INTRODUCTION

The rocks of the Gander Terrane (Zone) form an intervening belt between the Avalon Terrane, presumed to be underlain by sialic crust, and the Dunnage Terrane, underlain by oceanic crust (Figure 1; Williams, 1979; Williams *et al.*, 1974). There is general consensus that the Gander and Avalon terranes are separated by the Hermitage Bay Fault zone, a complex zone of ductile to brittle movements. In contrast, the nature of the boundary between the Gander and Dunnage terranes is not as well defined. Clearly, the interpretation of the geology and tectonics of the Gander Terrane is critical to an understanding of the evolution of terranes in central Newfoundland. In southwestern Newfoundland, there is little consensus on the geology and the interpretation of the Gander Terrane. This contribution represents an attempt to resolve some of the controversies in that region, and to assess the implications for the geology and tectonics of the Gander Terrane as a whole.

Gander Terrane in Northeastern Newfoundland

The northeastern Gander Terrane has long been separated into three units, which, from west to east, are respectively the Gander Group, the Square Pond Gneiss and the Hare Bay Gneiss. The Gander Group comprises thick, moderately metamorphosed psammites, largely of turbidite origin, and subordinate semipelites. Locally there is a well-developed pressure-solution cleavage (see Plate 1 in Dickson, 1987). The Square Pond Gneiss is also largely psammitic, lithologically resembles the Gander Group, and locally contains relics of an earlier pressure-solution cleavage (personal observation). The Hare Bay Gneiss forms a belt adjacent to the Dover Fault, and consists of complex granitoid orthogneiss, psammitic to semipelitic migmatites and amphibolitic gneisses, and numerous granite intrusions.

These units, once thought to represent cover and basement complexes, are now considered more likely to be variably metamorphosed, lateral equivalents of one another (Blackwood, 1978); but the Hare Bay Gneiss may well contain components of probable basement material as well as components of the Square Pond Gneiss (personal observation).

Along the northwestern flank of the Gander Terrane, the beginning of the Dunnage Terrane is probably represented by the rocks of the Davidsville Group. These are weakly metamorphosed turbidites and shales (but locally staurolite schists), with olistostromes or mélanges, and with belts of mafic and ultramafic rocks. A discontinuous belt of such

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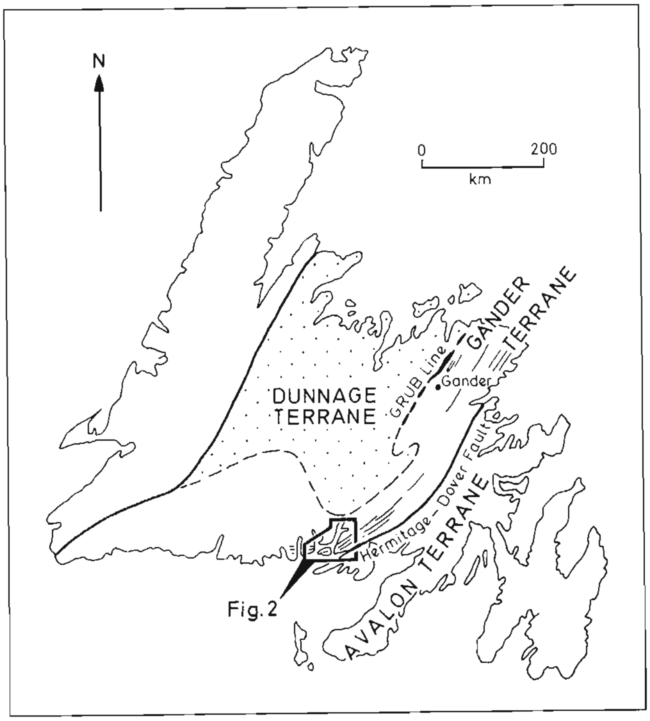

Figure 1. *Location of the area studied in relation to the terranes in central and eastern Newfoundland.*

rocks, the Gander River Ultrabasic Belt (the GRUB line; Figure 1) has been interpreted as marking a tectonic boundary between the Dunnage and Gander terranes (Blackwood, 1982). However, Pajari and Currie (1978) have indicated that the GRUB line represents a zone of mafic and ultramafic olistoliths within the black shales of the Davidsville Group. The critical contact between the Davidsville and Gander groups has been described as a conformable sedimentary transition (Pajari and Currie, 1978; Blackwood, 1982; Pajari *et al.*, 1979). However, the present author's preliminary examination of this contact southeast of the GRUB line, indicates that it is a tectonic break, defined by a zone at least 1 km wide, of ductile mylonites and ultramylonites developed from rocks of both assemblages. In this tectonic contact zone, numerous kinematic indicators, such as S–C foliations and shear bands *(sensu* Berthé *et al.*, 1979; see also Plates 1 and 2) indicate south- to southwest-directed sense of shear movements. This implies that the Davidsville Group has been thrust over the Gander Group, overriding it in a southwesterly direction.

The tectonics of the northeastern Gander Terrane have been the subject of an investigation by Hanmer (1981), who concluded that:

1) much of the region represents a zone of ductile, sinistral shearing some 60 km wide, of presumed Acadian age;

2) in this shear zone, the intensity of shear strain and of related metamorphic grade increased toward the Gander–Avalon boundary; and

3) the shearing was accompanied by emplacement of diapiric granites, most numerous within the belt of highest shear strain and maximum metamorphism, that is, in the Hare Bay Gneiss adjacent to the Dover Fault.

Gander Terrane in Southeastern Newfoundland

In the region of Bay d'Espoir (Figures 1 and 2), rocks of the Gander Terrane form a belt of psammitic and semipelitic schists and migmatites called the Little Passage Gneiss. These are structurally overlain by the Baie d'Espoir Group, an assemblage of metasedimentary and volcanic rocks, which may be more closely related to the Dunnage than to the Gander assemblage (cf. Colman-Sadd and Swinden, 1984). The Little Passage Gneiss forms a belt some 10 km wide, adjacent to the Hermitage Bay Fault zone. Like the Hare Bay Gneiss of the northeastern Gander Terrane, this belt of gneiss also includes a regional belt of steeply inclined rocks, is associated with the regional development of highest grade metamorphism, and is associated with the zone of most numerous granite intrusions. The regional metamorphic grade decreases toward the northwest, from sillimanite-bearing migmatite to garnet–staurolite–fibrolite schists in the Little Passage Gneiss, and from chlorite–biotite–garnet to chlorite–biotite in the Baie d'Espoir Group. The rocks of the Baie d'Espoir Group adjacent to the gneiss, are black, graphitic pelites and psammites with felsic and mafic tuffs and flows of the Isle Galet Formation. Northwestward, the Baie d'Espoir Group consists largely of turbiditic and shaly rocks of the Riches Island and St. Joseph's Cove formations.

In this southeastern region, controversy relates particularly to structural field observation and, in consequence, to the resultant interpretation of the regional tectonics and stratigraphy.

Early workers assigned all the metasediments in the Bay d'Espoir–Hermitage Bay region to a Baie d'Espoir Series (Jewell, 1939), later the Baie d'Espoir Group of Anderson (1967), believed to be of Ordovician age on the basis of fossil occurrences. Following detailed mapping in the Bay d'Espoir area, Colman-Sadd (1974, 1976; see also Colman-Sadd, 1980) interpreted the Little Passage Gneiss as a metasedimentary assemblage distinct from the rest of the Baie d'Espoir Group on structural–metamorphic and lithological grounds; such grounds include the confinement of a minor suite of muscovite–garnet–tourmaline granite and related pegmatite to the Little Passage Gneiss, and confinement of well-developed felsic volcanics to the Baie d'Espoir Group. He assigned the Little Passage Gneiss to a basement complex of Precambrian (?) age, upon which the Baie d'Espoir Group sediments were deposited. He interpreted the contact between these assemblages as a thrust (the Day Cove Thrust; Figure 2), in which the old structures in the gneisses were reworked and the inferred unconformity obliterated.

However, Blackwood (1985) in a report on the adjacent Facheux Bay map area that overlaps into Bay d'Espoir, concluded that there was no stratigraphic, structural or metamorphic evidence for significant dislocation or structural

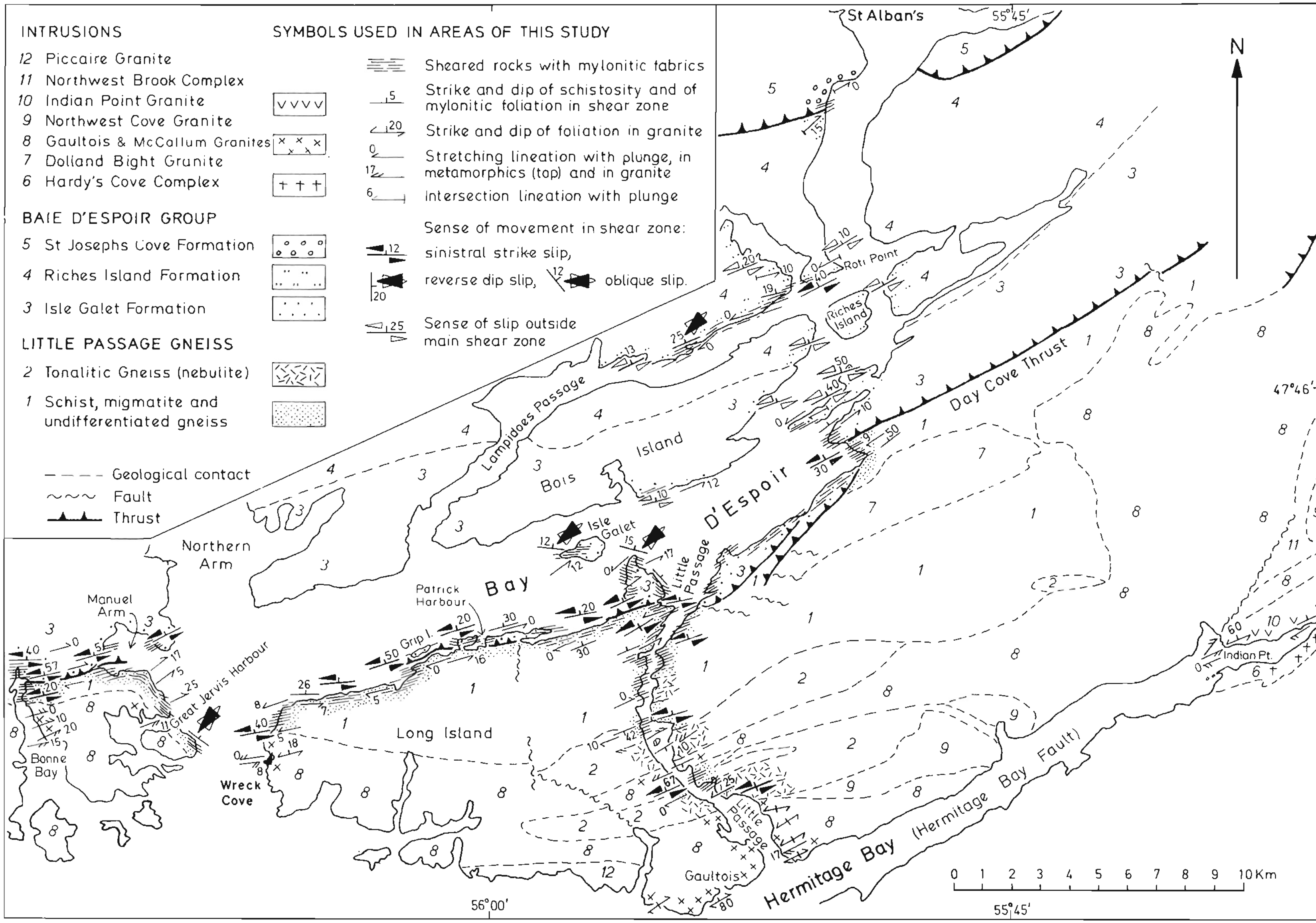

Figure 2. *Simplified geology of the Bay d'Espoir–Hermitage Bay area, showing the extent, the geometry and the sense of movement in the major shear zone. Geology, after Colman-Sadd and Swinden (1982), Colman-Sadd et al., (1979) and Blackwood (1985), listed in the left column of legend. Symbols in the central and left columns of legend refer only to the areas covered in this study.*

reworking between the Little Passage Gneiss and the Isle Galet Formation. On this basis, he effectively restored the original stratigraphy of Jewell (1939) and Anderson (1967), correlating the Little Passage Gneiss with stratigraphically higher units of the Isle Galet Formation.

In an attempt to resolve some of this controversy, in the summer of 1987 the writer carried out a four-week long, boat-supported investigation of the well-exposed shores of the Bay d'Espoir region, from Hermitage Bay in the east to Bonne Bay in the west (Figure 2).

BAIE D'ESPOIR GROUP–LITTLE PASSAGE GNEISS CONTACT ZONE

This contact zone was examined along the Harbour Breton highway (Route 360), along the coast of Bay d'Espoir, in Manuel Arm and in Bonne Bay (Figure 2). It was found to be followed by a major zone of ductile mylonites derived from the rocks of both assemblages. The zone of highest strain, in which ultramylonites (nomenclature after White, 1982) are well developed, corresponds with the trace of the Day Cove Thrust. However, mylonites and protomylonites are commonly developed over a zone up to some 10 km wide, as from Isle Galet into Little Passage, where the rock sequence may be partly repeated by folding and faulting. In Manuel Arm, the main mylonitic zone reaches a width of 2 km before it is cut by granite. Six kilometres north of the main zone, a related belt of rocks with less intense mylonitic fabrics, approximately one kilometre thick, follows the north shore of Lampidoes Passage.

Mylonitic Rocks in the Baie d'Espoir Group

The unit of the Baie d'Espoir Group that is in contact with the Little Passage Gneiss is the Isle Galet Formation. It consists of black pelite, commonly graphitic and generally phyllitic to schistose, which contains numerous beds of massive, felsic tuffs and rarer mafic rocks (Colman-Sadd, 1974, 1980; Blackwood, 1985).

As the black pelites are traced into the mylonitic zone, their bed-parallel foliation intensifies, the rocks become attenuated, such that in the zones of highest strain they become thinly layered phyllonites (phyllosilicate mylonites). They also develop subconcordant veinlets of quartz, which vary in size from microscopic to a few metres in length. Such veins are also present outside the mylonite zone, but they reach swarm proportions in the mylonitic rocks (Plate 1); some are surrounded by biotite–chlorite selvages, indicating probable derivation by the processes of strain-induced segregation. Such swarms of subconcordant quartz veins are typical of ductile shear zones at the base of the Fleur de Lys Supergroup, along the Baie Verte Line and in the southern Long Range in Newfoundland (Piasecki, 1987), in the Grenville Province of Ontario (personal observation), and in Scotland (Piasecki and van Breeman, 1983). The phyllonites in the high-strain zones contain pervasive developments of S–C mylonite foliations and shear bands (*sensu* Berthé *et al.*, 1979) that range in scale from 0.5 cm to more than 10 cm. This can impart to the phyllonites the appearance of 'button schist'. Excellent examples can be seen along the south coast of Bay d'Espoir near Patrick Harbour and on Grip Island (Plate 2).

The massive felsic volcanics, which locally form lenticular-shaped units within the phyllonites, also undergo progressive fabric changes. The tuffs and flows, often with phenocrysts of quartz and feldspar (see Plate 10 in Blackwood, 1985), develop a bed-parallel foliation, which intensifies, such that in zones of high strain the rocks become mylonites and ultramylonites. In many localities, as around The Barasway in Manuel Arm, such ultramylonites derived from felsic tuff become difficult to distinguish from ultramylonites derived from granite sheets in the Little Passage Gneiss. The felsic and mafic volcanics contain profuse developments of S–C mylonite foliations and shear bands (Plate 1). There are also rotated porphyroclasts (see Passchier and Simpson, 1986), small-scale asymmetric boudinage, and minor asymmetric folds. A stretching lineation also progressively develops in the volcanic rocks, and becomes very intense with increasing strain. It is defined by a parallel alignment of ribbons of granulated and dynamically recrystallized grains of quartz and feldspar (cf. Plate 3). In contrast with the competent felsic volcanic rocks, in which the stretching lineation forms a major element of the fabric, this lineation is only weakly developed in the less competent phyllonites.

It is now well known that these fabric elements are indicative of simple shear deformation and are typical of ductile thrust zones (Berthé *et al.*, 1979; White *et al.*, 1980; Hanmer, 1981; Simpson and Schmid, 1983; Lister and Snoke 1984; Weijermars and Rondeel, 1984; Ramsay and Huber, 1987). The profuse development of these fabric elements in the highly strained rocks around Bay d'Espoir clearly indicates the presence of a major ductile shear zone in this region.

Several minor belts of sheared rocks occur north of the main mylonite zone. These are more widely spaced, narrow in outcrop, and consist of weakly developed protomylonites with sigmoidal tension fractures, shear bands and occasional S–C foliations.

Mylonitic Rocks in the Little Passage Gneiss

The Little Passage Gneiss structurally underlies the Baie d'Espoir Group along a highly sheared contact marked by a spectacular development of mylonites and ultramylonites. Colman-Sadd (1974, 1976, 1980) recognized this contact as a tectonic boundary (the Day Cove Thrust). He also recognized that the movements on this thrust (assumed to have been toward the southeast) had reworked the Little Passage Gneiss for some distance below the thrust surface.

The Little Passage Gneiss is an assemblage of psammitic and some semipelitic schists and gneisses, with local development of amphibolitic schist and gneiss (for a detailed description see Colman-Sadd and O'Driscoll, 1979). Adjacent to the Baie d'Espoir Group, semipelitic mylonitic schists

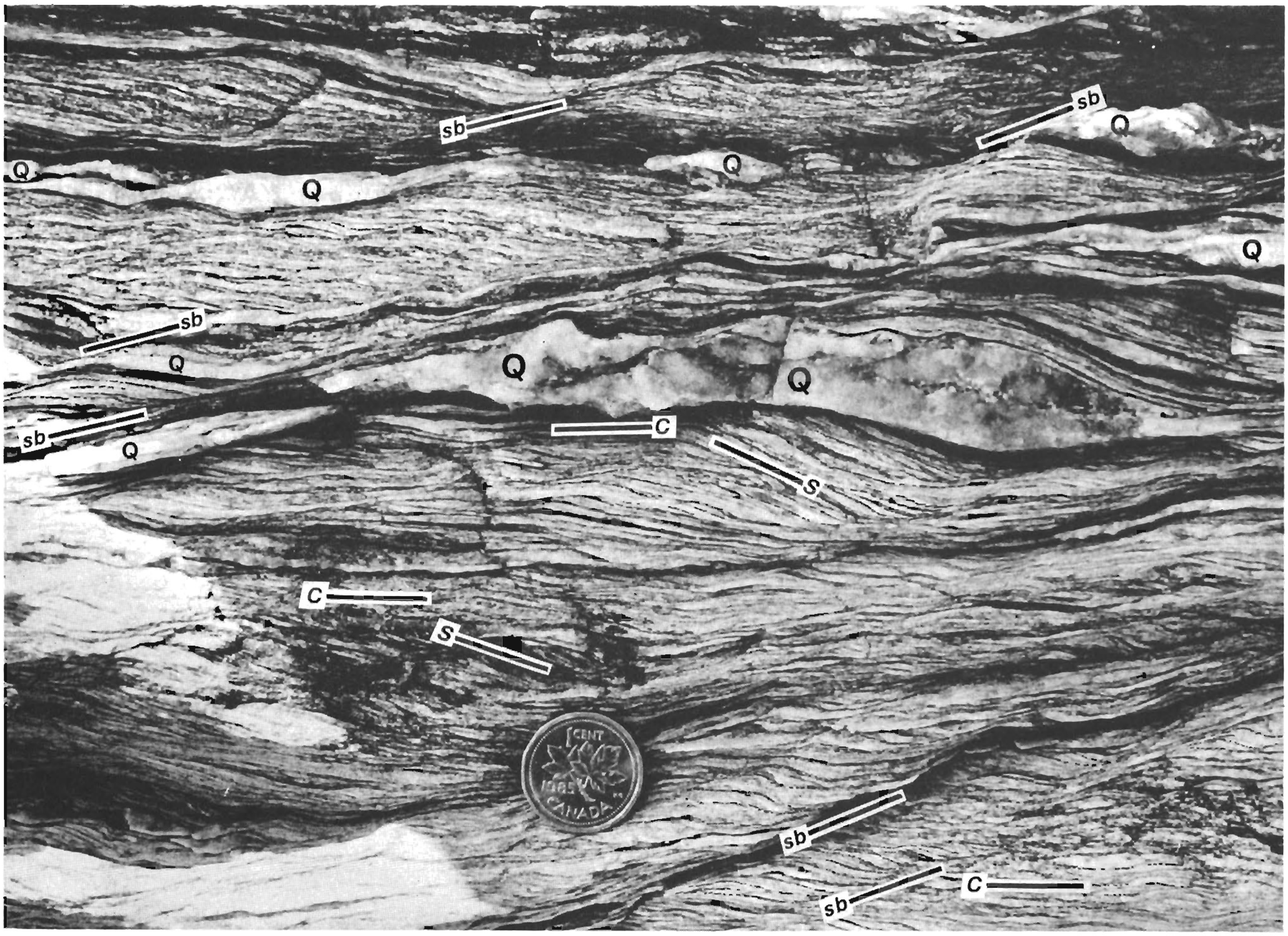

Plate 1. *Common indicators of simple shear strain and of the sense of movement in a sheared rock. Mylonite after felsic tuff, showing penetrative development of S-C foliation (S,C) and shear bands (sb). A swarm of segregation-type quartz veins (Q) emphasizes the slip on the shear bands. The sense of shear movement is left lateral; the plane of exposure is parallel to an intense stretching lineation (cf. Plate 3). Cliff at east end of bay immediately east of Patrick Harbour.*

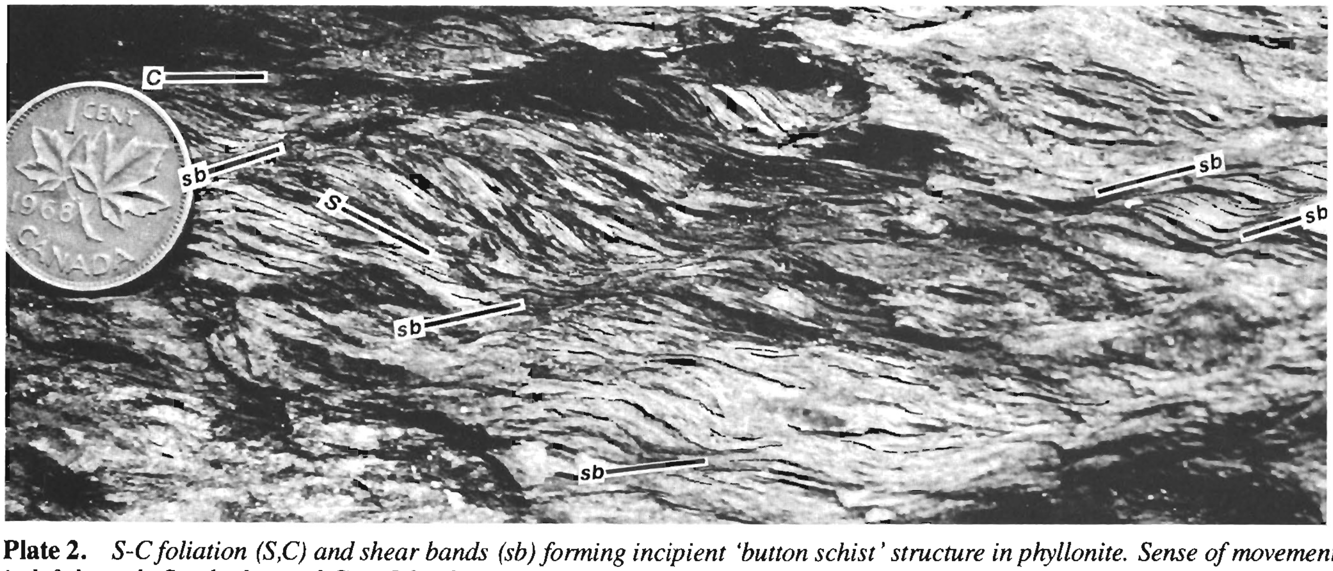

Plate 2. *S-C foliation (S,C) and shear bands (sb) forming incipient 'button schist' structure in phyllonite. Sense of movement is left lateral. South shore of Grip Island.*

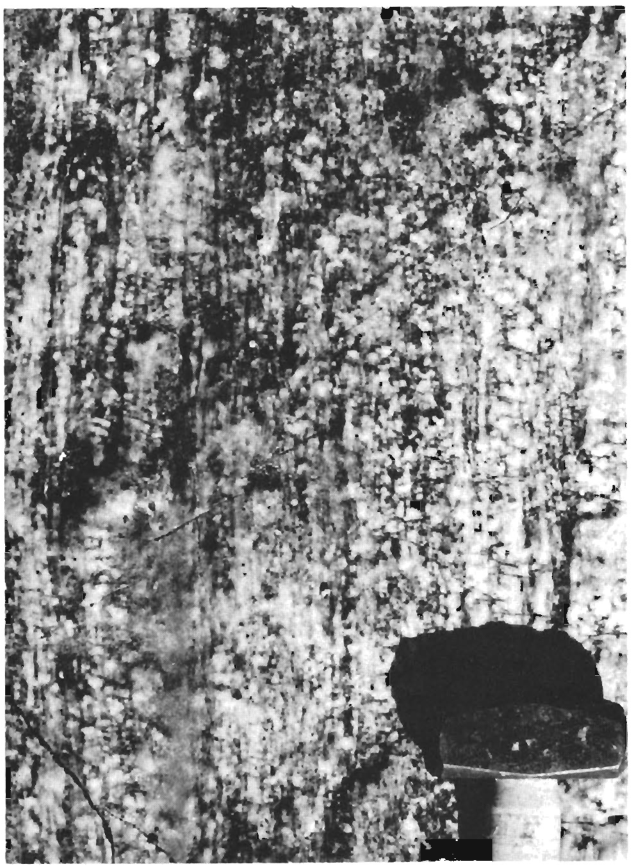

Plate 3. *Intense stretching lineation, defined by aligned ribbons of granular aggregate of feldspar and quartz. These represent originally large grains in the granite, granulated and dynamically recrystallized into aggregates of small equigranular grains, then pulled out into ribbons in the direction of the maximum extension in the shear zone. Muscovite–tourmaline granite sheet in the Little Passage Gneiss, north shore of Long Island.*

contain garnet–fibrolite assemblages that appear to be syntectonic with the shearing movements. Locally, they contain posttectonic staurolite. Toward the Hermitage Bay Fault zone, the metasediments become progressively engulfed by voluminous granite, where they pass into coarse migmatites (see Plate 30 in Blackwood, 1985) and nebulites. Locally, these rocks are associated with gneisses that could represent elements derived from a deeper basement.

The Little Passage Gneiss rocks are mylonitic for at least 4 km south of their boundary with the mylonites of the Baie d'Espoir Group. Zones of protomylonitic to mylonitic, gneissic metasedimentary rocks can be seen amongst the granites for a farther 3 km, beyond which few metasediments have been observed. The mylonites adjacent to the Baie d'Espoir Group are well exposed along the northern shore of Long Island and along the southern shore of Manuel Arm. These mylonites, and locally protomylonites, contain swarms of subconcordant veinlets of quartz and of quartz–feldspar segregations, as well as developments of S–C mylonite foliations and shear bands. They also contain a stretching lineation, defined by the alignment of most of their constituent minerals, which is best seen in the psammitic rocks. Their mylonitic microfabric parallels a thinly laminated compositional layering that probably represents highly attenuated and modified bedding.

Mylonitic Minor Intrusions in the Little Passage Gneiss

The Little Passage Gneiss mylonites also contain numerous sheets of leucocratic, muscovite–garnet–tourmaline granite and of apparently related pegmatite. A striking feature of these minor intrusions is their high degree of deformation into mylonites and protomylonites, and their intense, penetrative mineral lineation (Plate 3), parallel to that in the host mylonitic metasediments.

The pegmatities vary in degree of deformation. More highly deformed pegmatites form 'porphyroclastic gneisses' comprising rotated and partly granulated and dynamically recrystallized feldspar augens, around which a matrix of recrystallized feldspar and quartz forms an anastomasing pattern. Locally, some of the less deformed pegmatite sheets can be seen to be more discordant to the layer-parallel mylonitic foliation of the host metasediments than the more highly deformed pegmatites. In one instance, the main body of a 20-m-long sheet can be seen to cut the C-fabric of the mylonitic metasediment along the plane of the regional S-fabric. In contrast, the terminations of this sheet bend into C-fabric, presumably having been rotated into it by a later increment of the C fabric. Such relationships may be taken to indicate that the minor intrusions were emplaced during the shearing event.

Zone of Granite Intrusion

Traced toward the Hermitage Bay Fault zone, the minor intrusions within the Little Passage Gneiss give way to progressively larger granitic bodies, culminating in a belt of plutons adjacent to Hermitage Bay (Figure 2). The metamorphic grade in the metasedimentary rocks increases toward this plutonic belt: the rocks become migmatitic, at first with minor developments of nebulitic granite, then with a wide zone of an inhomogeneous nebulitic granite (tonalitic gneiss of Colman-Sadd, 1980; and Unit 2 in Figure 2). The nebulite commonly preserves remnants of a layering and of compositional signatures of the original metasediments. These are now seen as belts of highly siliceous nebulite carrying schlieren of psammite, or of micaceous nebulite with kernels of biotite and prismatic kyanite retrogressed to aggregates of fine grained muscovite. These resemble sillimanite-biotite knots in nearby semipelitic migmatites. Locally, the nebulite contains traces of well-banded gneisses, which could represent fragments of a deeper basement, implying that some parts of the nebulitic granite may have been substantially mobile.

The nebulitic granite locally encloses screens of variably migmatized metasediments with strongly mylonitic fabrics. Also, the nebulite locally develops a strong mineral lineation, mylonitic S–C foliations and rotated porphyroclasts, all aligned parallel to corresponding fabrics in the mylonites of the main shear zone.

Farther southeastward, the nebulitic granite passes into coarser, more homogenized types. These, with development of megacrystic feldspar, in turn pass into still coarser, megacrystic, clearly intrusive rocks: such is the Gaultois Granite, which contains numerous schlieren of nebulite, and even developments of layering. In some cases, the layering is folded, and is reminiscent of 'ghost stratigraphy' structures in migmatitic granites. Good examples can be seen in Wreck Cove, Great Jarvis Harbour and in Bonne Bay (examples at the latter two localities are in the McCallum Granite of Blackwood, 1985). The Gaultois Granite is usually steeply foliated. At its boundaries with the mylonitic metasediments, the granite tends to deflect their mylonitic foliation into subparallelism with its contact. Locally it develops a mineral stretching lineation, sometimes sufficiently intense for the rock to become an L-tectonite. Its linear and foliar fabrics generally have the same orientation and attitude as those in the shear-zone mylonites (Figure 2), suggesting emplacement during the shearing movements, in a manner similar to that discussed by Hanmer (1981) for the emplacement of syntectonic granites in the northeastern Gander Terrane.

The foliated and lineated nebulite and the megacrystic granites are intruded by several generations of later granitic intrusions that become progressively more homogeneous in composition. The earlier generations are locally lineated parallel to the lineation in the shear zone, but less intensely than their hosts; they are cut by subsequent bodies free from deformation fabrics, indicating that the granitic activity had accompanied and outlasted the ductile shearing.

At the head of Hermitage Bay, a pink granite, the Straddling Granite of Blackwood and O'Driscoll (1976), appears to straddle the Hermitage Bay Fault zone. In the course of this work, no ductile deformation fabrics were observed in the granite on the Avalon Terrane (Figure 1) side of the fault, which contains belts of brecciation and thin shears which have generated pseudotachylite. On the Gander Terrane side of the bay, a pink granite contains a foliation and local development of a stretching lineation typical of the Gander Terrane (Figure 2). These observations are consistent with the geochemical and isotopic evidence quoted by Elias and Strong (1982) for the pink granite on the Gander side of the fault, the Indian Point Granite, being distinct and substantially younger than the Avalon counterpart, the Hardy's Cove Complex.

Folding

The rocks with the wide belt of shearing show the effects of two phases of folding related to the development of the shear zone.

The earlier folds are isoclinal to close, asymmetric minor structures that frequently grade into intrafoliated folds. At their hinges, they fold the lithological layering *and* the layer-parallel, mylonitic C-foliation with its swarms of quartz segregation veins, but their axial surfaces are defined by a mylonitic C-fabric with more quartz veins. Clearly, these folds must have formed during the shearing movements. The folded C-foliation and the axial-surface C-foliation correspond, respectively, to a shear fabric already attained before fold development, and a later increment of this fabric formed at the time of the folding. The fold hinges vary in orientation from parallelism with the stretching lineation, to attitudes as high as 60° to this lineation. Many have curvilinear hinges and some locally develop into sheath folds (Cobbold and Quinquis, 1980; Hanmer, 1981), indicating rotation into the maximum extension direction in the shear zone.

The later folds, which refold the asymmetric and intrafolial structures, are upright to steeply inclined, more open in profile, and range from minor structures to folds with wavelengths of the order of a kilometre. Their axial surfaces are commonly marked by steep- to upright-crenulation cleavages. The intersection of these cleavages with the main foliation defines an intersection lineation of common occurrence throughout the region. The fold hinges and this intersection lineation are subparallel to the regional shear-related stretching lineation. The upright folds are present throughout the region, but, as seen in Little Passage, they reach their maximum development in the belt of migmatite and granite. There, they fold the foliation in the nebulites and in the megacrystic granites; their hinges are parallel with the locally developed stretching lineation in the intrusives that are believed to be syntectonic with the shearing. The upright folding appears to be related to a subhorizontally directed flattening strain, which seems to have accompanied the later stages of the shearing movements. Locally, it has led to the development of minor sets of conjugate strain-slip cleavages that closely resemble synthetic and antithetic shear bands (see Lister and Snoke, 1984).

Sense of Tectonic Transport and Geometry of the Shear Zone

In the Bay d'Espoir region (Figure 2), the mylonitic rocks abound in fabric elements, which are well known to be generated by simple shear strain, and which can be used as kinematic indicators for determining the sense of tectonic movements in the shear zone (Simpson and Schmid, 1983; Passcher and Simpson, 1986; White *et al.*, 1986). The most useful are the S−C foliations and shear bands developed in almost all the mylonitic rocks (Plates 1 and 2), and the rotated feldspar porphyroclasts present in the mylonitic felsites of the Isle Galet Formation and in the mylonitic granite sheets and pegmatites within the Little Passage Gneiss. As seen in Figure 2, on the regional scale of Bay d'Espoir, in the main belt of shearing, and also in the zone of minor slip in Lampidoes Passage, these kinematic indicators systematically point to a sinistral (left lateral) strike-slip movement relative to the layer-parallel mylonitic foliation. Only in the Little Passage Gneiss immediately north of Great Jervis Harbour is this sense of movement not so clearly defined, and, in fact, it may be reversed, suggesting the possible presence of an overturned limb of a subrecumbent fold. The derived sense of regional shear transport is supported by the consistency in the orientation and attitude of the stretching lineation in all the mylonitic rocks within the shear zone, taken to correspond with the regional maximum extension axes (the X-axes).

Thus, along the shore of Bay d'Espoir, the thick zone of ductile shearing has the geometry of a gently inclined, layer-parallel zone of overthrusting toward the west-southwest.

The regional trend of the layer-parallel, mylonitic fabric changes locally, e.g., south of Manuel Arm, where it appears to have been deflected by the emplacement of granite. However, the mylonitic stretching lineation maintains its regional course without deflection, and related kinematic markers point to continued sense of transport toward the west-southwest. This relationship indicates that the granite may have been emplaced at the time of the shearing movements, deflecting the earlier formed mylonitic foliation, but being affected by the subsequent mylonitic fabric.

Traced southeastward along Little Passage into the higher grade rocks, the gently inclined, layer-parallel shear zone bends upward, reaching a subvertical attitude in the belt of syntectonic granite adjacent to the Hermitage Bay Fault zone. The sense of movement remains left-lateral, the geometry of the shear zone becomes that of a zone of subvertical strike-slip (transcurrent) movement.

SUMMARY AND CONCLUSIONS

On the Scale of the Bay d'Espoir Region

This work indicates that a major belt of ductile shearing, several kilometres thick and accompanied by regional amphibolite-facies metamorphism, separates the Baie d'Espoir Group from the Little Passage Gneiss. Along this shear belt, the volcanic and metasedimentary rocks of the Baie d'Espoir Group have been thrust to the west-southwest over the Little Passage Gneiss *in a direction subparallel to the trend of the Appalachian Orogen* in Newfoundland, and to the trend of the major terrane boundaries. This sense of tectonic transport, previously unrecorded in this part of the Gander Terrane, has been derived by systematic observation of abundant, clearly defined, kinematic indicators related to an intense, penetrative regional stretching lineation. Evidence for northwest-southeast movements has not been recorded.

This shear zone has the attitude of a gently inclined thrust in the region of Bay d'Espoir, but in the direction of the Hermitage Bay Fault zone it passes gradually into a steep zone of sinistral strike-slip movement. Its steep attitude corresponds with the zone of granite intrusions, believed to be syn- to late-tectonic with the shearing movements.

The relationship between the Baie d'Espoir Group and the Little Passage Gneiss has been previously interpreted as a lateral sedimentological transition (Blackwood, 1985) and as distinct assemblages (Colman-Sadd, 1974). The new data adds further support to the distinct nature of these assemblages, in that the Baie d'Espoir Group is allochthonous, transported for an unknown distance over the Little Passage Gneiss.

On the Scale of the Gander Terrane

The present observations from the southeastern Gander Terrane are remarkably consistent with the observations of Hanmer (1981) from the northeastern Gander Terrane.

The data of this study and that of Hanmer's (1981), collectively indicate that the whole eastern flank of the Gander Terrane in central Newfoundland corresponds with a major zone of ductile shearing. This shearing is expressed by overthrusting toward the southwest in a central flat belt, which then passes into sinistral strike-slip (transcurrent) movements within the steep belt of granite-injected rocks adjacent to the boundary with the Avalon Terrane. This zone of shearing could represent an initially subhorizontal overthrust upturned by the rise of the syntectonic granite diapirs (cf. Figure 9 in Hanmer, 1981). Alternatively, the subhorizontal thrusting may be related to more fundamental movements in a vertical transcurrent zone, perhaps associated with early, ductile stages of evolution of the Dover—Hermitage Bay Fault zone.

Tectonically significant is the new observation that in the northeastern Gander Terrane, the boundary between the Gander and Davidsville groups (the presumed boundary between the Gander and Dunnage terranes) is, at least locally, a zone of ductile shearing along which the Davidsville Group appears to have overthrust the Gander Group in a southwesterly direction. It suggests that the whole of the Gander Terrane *and* at least the eastern flank of the Dunnage Terrane represent a series of allochthonous slices that have travelled subparallel to the axes of the orogen.

Colman-Sadd and Swinden (1984) have proposed that the Baie d'Espoir, Davidsville and Victoria Lake groups may be members of an allochthonous Dunnage Terrane that has been thrust upon Gander (?) elements exposed in tectonic windows (Mount Cormack Terrane). On such a model, the Bay d'Espoir shear zone, and the shear zone observed at the boundary between the Gander and Davidsville groups north of the town of Gander, could be segments of a major zone of ductile thrusting at the base of this allochthon. In Bay d'Espoir, this thrusting may have cut out, perhaps along a lateral ramp, all the Gander elements other than the Little Passage Gneiss.

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