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REGIONAL STRIATION SURVEY AND DEGLACIAL HISTORY OF THE NOTRE DAME BAY AREA, NEWFOUNDLAND

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ABSTRACT

Results from reconnaissance-striation mapping in the Notre Dame Bay area, north-central Newfoundland (covering NTS map areas 2E/2, 3, 6, 7, 9, 10, 11 and the east half of 2E/4 and 5) suggest a complex ice-flow history for the area, having at least four separate ice-flow events. The earliest ice-flow direction was east-southeast, followed by a second ice-flow direction trending north-northeast. The third ice-flow event ranged from a northeast flow in the west of the study area to a northwest flow in the east. Evidence for these first three events has been found over most of the study area. The most recent ice-flow event was a local, small-scale east-southeast-trending event recorded only in the west of the study area.

This study represents the most detailed regional reconnaissance-striation survey conducted in the area, upon which a tentative new re-interpretation of the glacial history of the region is made. Coalescence of ice caps, centred on the Northern Peninsula and in central Newfoundland occured during the Late Wisconsinan glacial maximum. As deglaciation progressed, the central Newfoundland ice-cap initially separated from the Northern Peninsula ice-cap and subsequently split into at least three ice-centres. Final decay of the central Newfoundland ice cap resulted in minor ice-centres, which may have briefly readvanced.

INTRODUCTION

The Notre Dame Bay area is a region of considerable mineral exploration interest, especially for gold and base metals. Mineral exploration has been hampered by extensive overburden and a lack of information on the Quaternary geology of the region. A thorough understanding of the Quaternary ice-flow history could enhance efforts to trace mineralized float and geochemical anomalies detected in the overburden, to potential target areas.

Glacial striations are small grooves or scratches cut into the bedrock surface by rock fragments carried at the base of a glacier (Sugden and John, 1976). The orientation of these striations represent a record of the ice-flow direction at the time of their formation. Variations may occur in the orientation of individual striations, however, a compilation of striation sites may indicate a pattern of ice flow.

This striation-mapping project is intended to provide rapid regional coverage of areas with mineral potential much sooner than the more detailed but slower 1:50,000-scale surfical mapping program. Striation mapping is an effective method of obtaining a broad understanding of the (deglacial) ice-flow history over a wide regional area.

OBJECTIVE

The project objective is to conduct a reconnaissance-level mapping of glacial striations, at a 1:50,000 scale, of NTS map areas 2E/2, 3, 6, 7, 9, 10, 11 and the east half of 2E/4 and 5 (Figure 1).

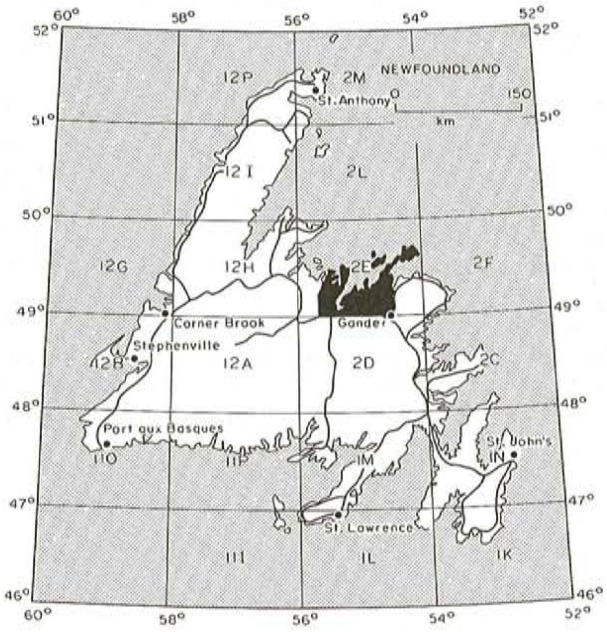

Figure 1. *Index map.*

PREVIOUS WORK

Jenness (1960), based on surfical mapping in the Terra Nova–Bonavista Bay area, suggested that ice flowed eastward across most of eastern Newfoundland from a source to the west of the Bay of Exploits. Prest *et al.* (1968) report a

northeasterly oriented ice-flow for the Gander Lake area and north-central Newfoundland. Grant (1977) proposed a north-northeast ice flow for north-central Newfoundland during the Late Wisconsinan maximum, from an ice cap in central Newfoundland. Ice-flow indicators have also been recorded in the region by bedrock and surfical mappers including MacClintock and Twenhofel (1940), Baird (1950), Hayes (1951), Lundqvist (1965), Hornbrook *et al.* (1975), Vanderveer and Sparkes (1980), Vanderveer (1983, 1987), Vanderveer and Taylor (1987), Proudfoot *et al.* (1988), Liverman and St. Croix (1989a), Taylor and St. Croix (1989), Batterson *et al.* (1991) and Liverman *et al. (this volume).*

Prest (1970) attributed a minimun of five and probably more ice-dispersal centres to the Island of Newfoundland. Grant (1974) suggested that the main Newfoundland ice cap split into fifteen remnant ice centres during deglaciation. Five of these remnant ice centres had the potential to influence ice-flow in north-central Newfoundland. Three of these ice centres were located in central Newfoundland, near Red Indian Lake, Meelpaeg Lake, and in the Middle Ridge area. The fourth was north of Grand Falls in the Twin Ponds area and the fifth was located near Gander.

Summaries of the glacial history of Newfoundland are given by Tucker (1976), Grant (1977, 1989), Rogerson (1982) and Brookes (1982).

FIELD METHODS

Field work consisted of truck traverses along all primary and secondary roads and all-terrain vehicle traverses along most logging and winter roads. All exposed bedrock surfaces were examined for striations and other erosional ice-flow indicators. Approximately 425 single or multiple striation sites were found and recorded during the 1990 field season (Taylor and St. Croix, 1990). Ice-flow direction, where possible, was determined from the morphology of the bedrock surface using such features as stoss and lee, nailheads, chattermarks and miniature crag and tails. Sites that contain two or more striation directions are intrepreted to be the result of either separate glacial advances or different ice-flow directions within one flow event. Relative temporal relationships between separate flows on multiple direction sites are indicated by crosscutting features and leeside preservation.

The data has been entered into a striation database and is available upon request.

RESULTS

The field data suggests four separate ice-flow events affecting the Notre Dame Bay area; Figure 2 shows distribution of these sites. The earliest ice-flow event trends east-southeast and was observed at between 10 and 15 percent of the field sites. The second ice-flow direction showed a consistent north-northeast orientation over the entire study area. The third ice flow was oriented to the northeast, in the west of the field area and northwest in the east. The orientation of this third ice-flow event varies along it's path, especially toward the coast, and probably reflects topographic control. The fourth, and possibly most recent ice flow, was a local east-southeast-trending event that occurred west and south of the Bay of Exploits. The absolute age of these ice-flow events is unknown.

INTERPRETATION

FIRST ICE-FLOW EVENT

The east-southeast ice flow is the first of the four glacial events recorded (Figure 3). Ice-flow indicators that pertain to this ice-flow event have consistently been preserved on the leeside surfaces of outcrops that show one or more subsequent ice-flow events. One of the earliest references to this flow was by Murray (1882) who noted that massive blocks removed from the parent rock of Mount Peyton were dispersed eastward along the southeast and eastern flank of the mountain. Jenness (1960) working in the Terra Nova–Bonavista map area proposed that ice from west of the Bay of Exploits flowed across all of eastern Newfoundland. In the Gander Lake–Mount Peyton area, east-oriented striations were also mapped to the south of the field area by Taylor and St. Croix, (1989) and Batterson *et al.* (1991), and to the east of the study area near Weir's Pond by Vanderveer (1987).

Further work is required west of Grand Falls to establish if this initial east-southeast flow is related to the Red Indian Lake dispersal centre proposed by Grant (1974). The relationship of this east-southeast ice flow to striations recorded in the Great Gull Lake area (Vanderveer, 1983) and in the Millertown area (MacClintock and Twenhofel, 1940; Vanderveer and Sparkes, 1980) also needs re-examination.

Ice flows in response to gravity and should flow downslope (Paterson, 1981). The first ice flow follows an east-southeast course across northeastern Newfoundland rather than toward the coast and into Notre Dame Bay. An explanation for this behaviour is that ice may have flowed from the Northern Peninsula into Notre Dame Bay causing a deflection of ice flowing from the Red Indian Lake area eastward toward Bonavista Bay. Evidence for the east-southeast-oriented striations have been found on the Horse Islands, to the north of the Baie Verte Peninsula during the 1989 field season (Terrain Sciences Section, unpublished data) and in the La Scie area of the Baie Verte Peninsula (Liverman and St. Croix, 1989a). The relative chronology of these events is not known.

SECOND ICE-FLOW EVENT

The second ice flow has a north-northeast trend and is relatively consistent over the entire study area (Figure 4). Striations indicating a similiar flow direction have been mapped in and around the field area by Baird (1950), Hayes (1951), Lundqvist (1965), Hornbrook *et al.* (1975), Vanderveer and Sparkes (1980), Vanderveer (1983, 1987), Vanderveer and Taylor (1987), Taylor and St. Croix (1989) and Batterson *et al.* (1991).

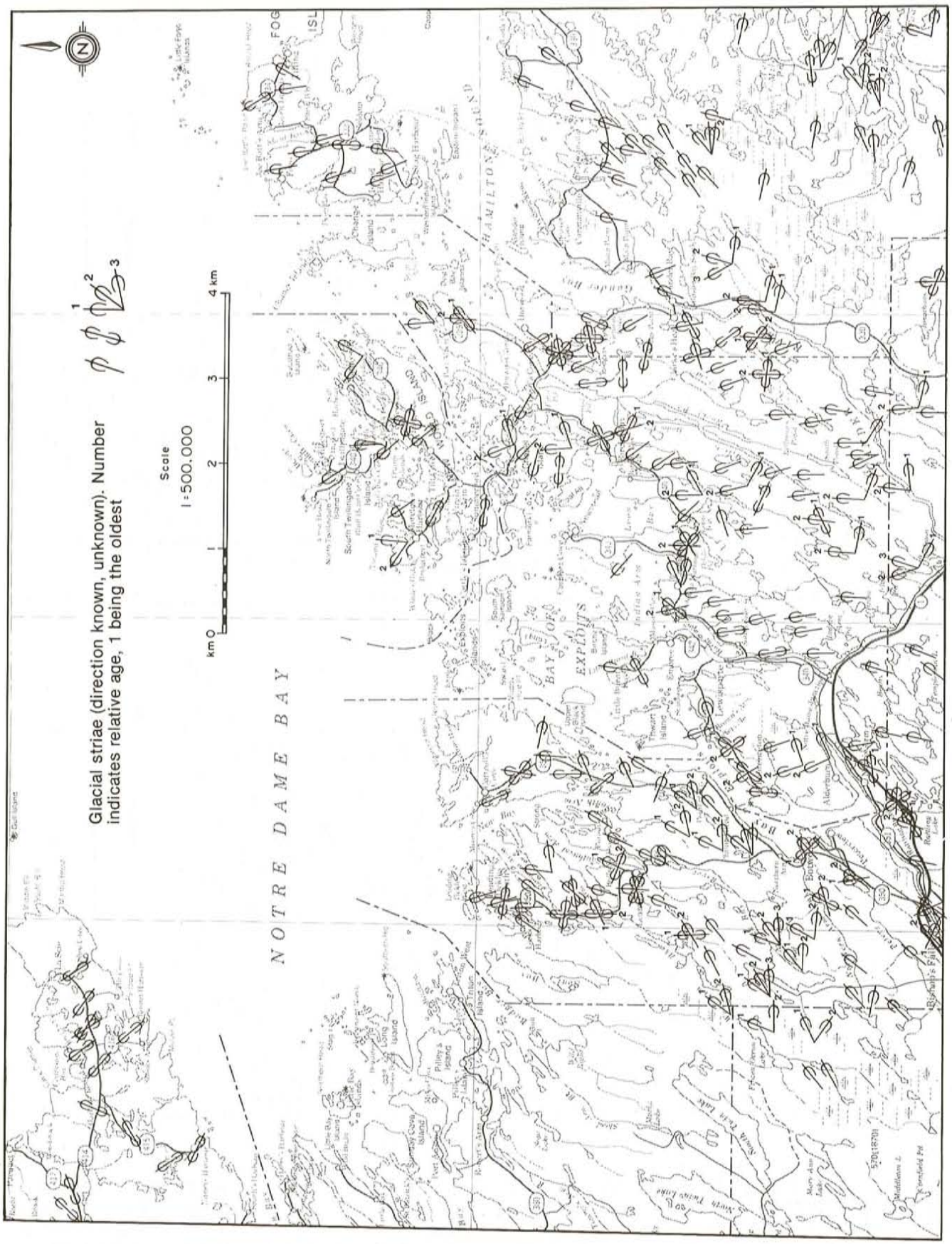

Figure 2. *Ice-flow indicators in the Notre Dame Bay area, Newfoundland.*

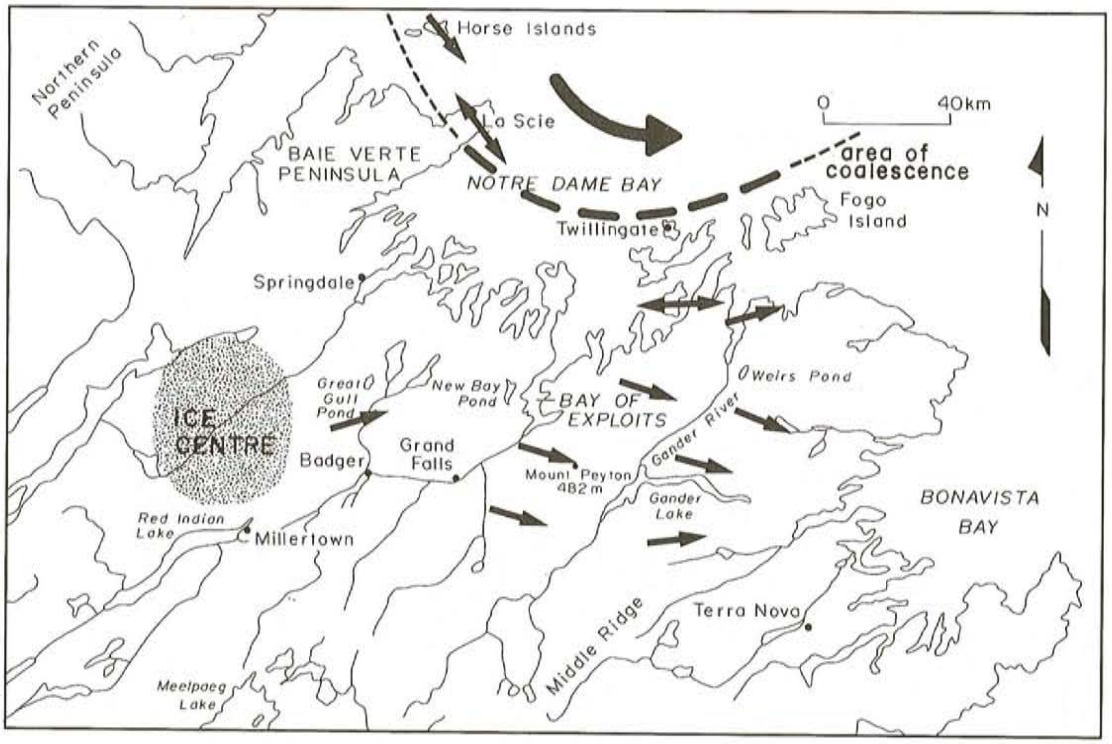

Figure 3. *First ice-flow event.*

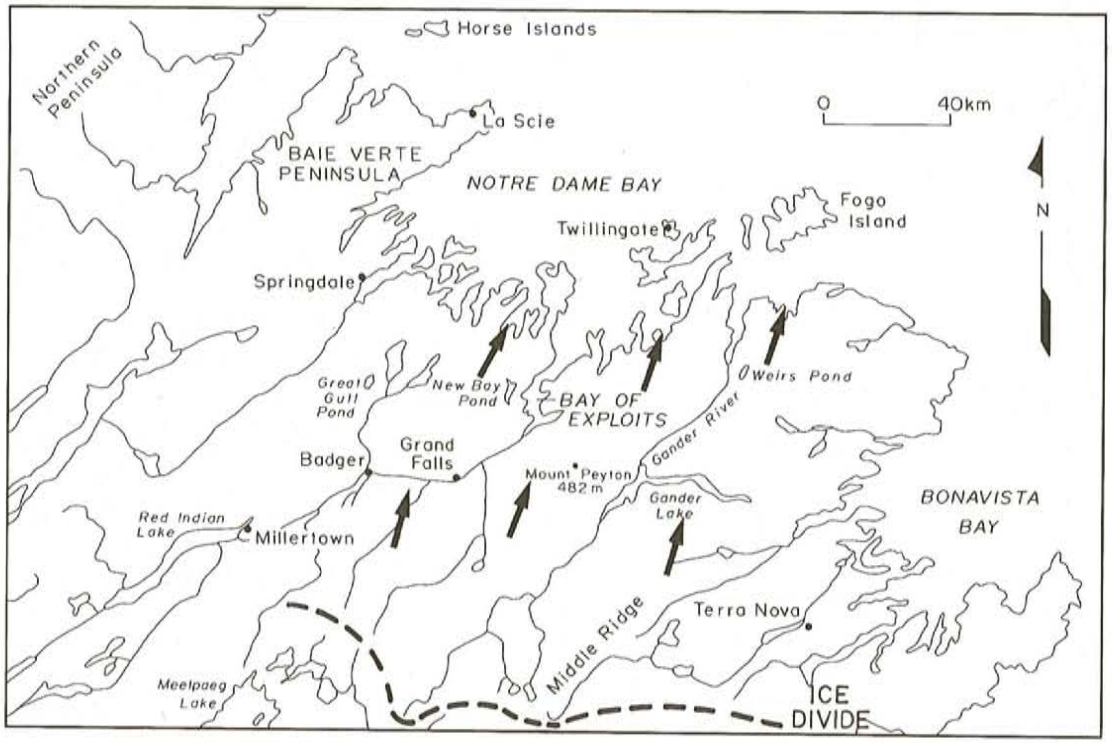

Figure 4. *Second ice-flow event.*

Prest *et al.* (1968), Grant (1977) and Rogerson (1982) indicated that a northeast ice flow was dominant in north-central Newfoundland. The broad coverage and consistency of the north-northeast ice flow indicates a possible ice divide, directly south of the study area along the height-of-land illustrated by Jenness (1960). Grant (1974) suggested a similiar ice divide arcing across the Island from the southwest to the east. Further evidence of an ice divide is provided by Proudfoot *et al.* (1988), who intrepreted the dominant ice flow in south-central Newfoundland to be south to southeast from

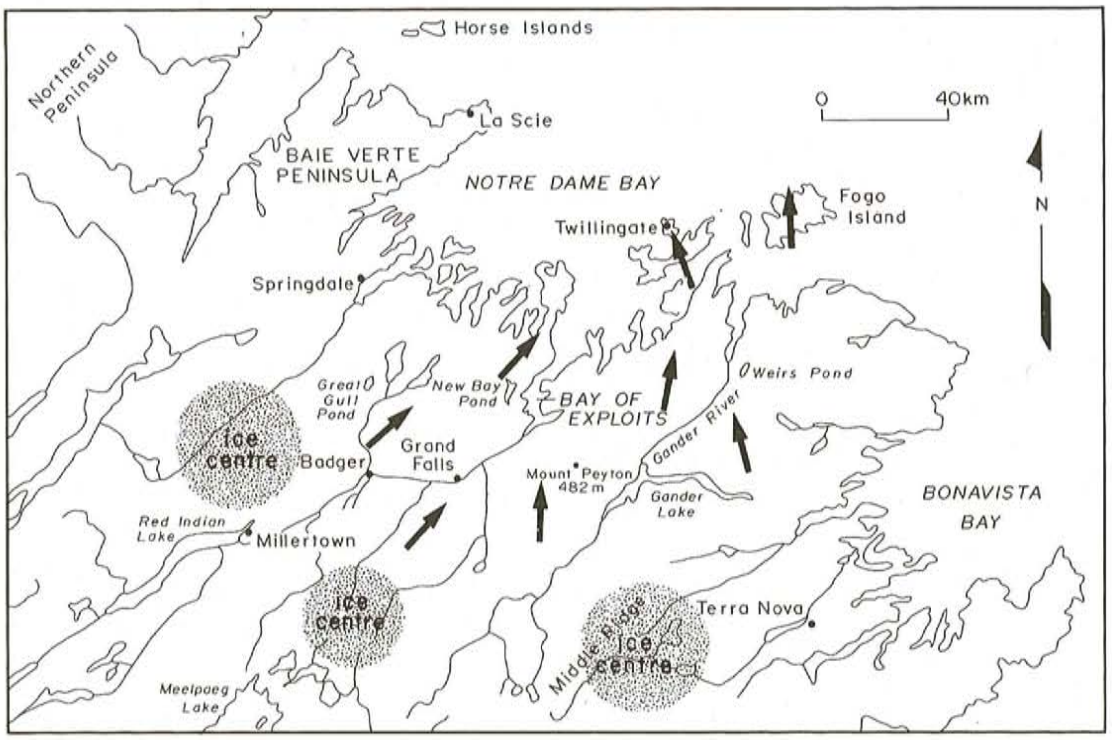

Figure 5. *Third ice-flow event.*

a source located in central Newfoundland. Although we cannot be certain that this southward flow coincided with the north-northeast flow in the north, there is only evidence for one ice-flow in the south so it is likely that they coincide.

THIRD ICE-FLOW EVENT

The third ice-flow event is to the northeast in the west of the field area and to the northwest in the east (Figure 5). This ice flow consistently crosscuts the earlier (second) north-northeast flow when observed on the same outcrop. Most of the previous workers did not separate this (the third) flow from the earlier (second) north-northeast ice flow, possibly because striation mapping was not their primary goal or because the area they investigated was not large enough. However, striations recorded by Hornbrook *et al.* (1975), Vanderveer and Taylor (1987) and Taylor and St. Croix (1989) do indicate two separate northward flows.

This third flow represents either two separate, but local ice-flow events or two contemporaneous ice flows across the area. Using Grant's (1974) theory of multiple shrinking ice caps, the north to northwest ice flow to the east of the Bay of Exploits may be related to a Middle Ridge ice centre, and to the west of the Bay of Exploits the northeastward ice flow may be related to an ice centre near Red Indian Lake.

FOURTH ICE-FLOW EVENT

A fourth and final ice flow in the region, was a relatively local, late phase event (Figure 6). This east-southeast-oriented ice flow was located south and west of the Bay of Exploits; and may be related to Grant's (1974) remnant ice centre in the Twin Ponds area north of Grand Falls. Similiar striations have also been mapped in the New Bay Pond area (Hornbrook *et al.*, 1975) and in the Grand Falls–Mount Peyton area (Taylor and St. Croix, 1989).

The final ice-flow event may be related to a cooling episode following initial deglaciation identified in north-central Newfoundland by Eyles (1977), Macpherson and Anderson (1985) and Liverman and St. Croix (1989b), which may have resulted in a readvance of remnent ice in the Springdale area (Liverman *et al., this volume).*

TENTATIVE GLACIAL HISTORY

A tentative sequence of events in the deglaciation of north-central Newfoundland is postulated based on data collected during this survey and the work of others discussed above:

1) Coalescent ice caps were centred on the Northern Peninsula and central Newfoundland at the Late Wisconsinan maximum;

2) during the early stages of deglaciation these ice caps separated, permitting the central Newfoundland ice cap to flow from either an ice divide or an ice cap to some point past the modern coastline;

3) as deglaciation progressed, the central Newfoundland ice cap split into several independent ice caps producing their own ice flows; and

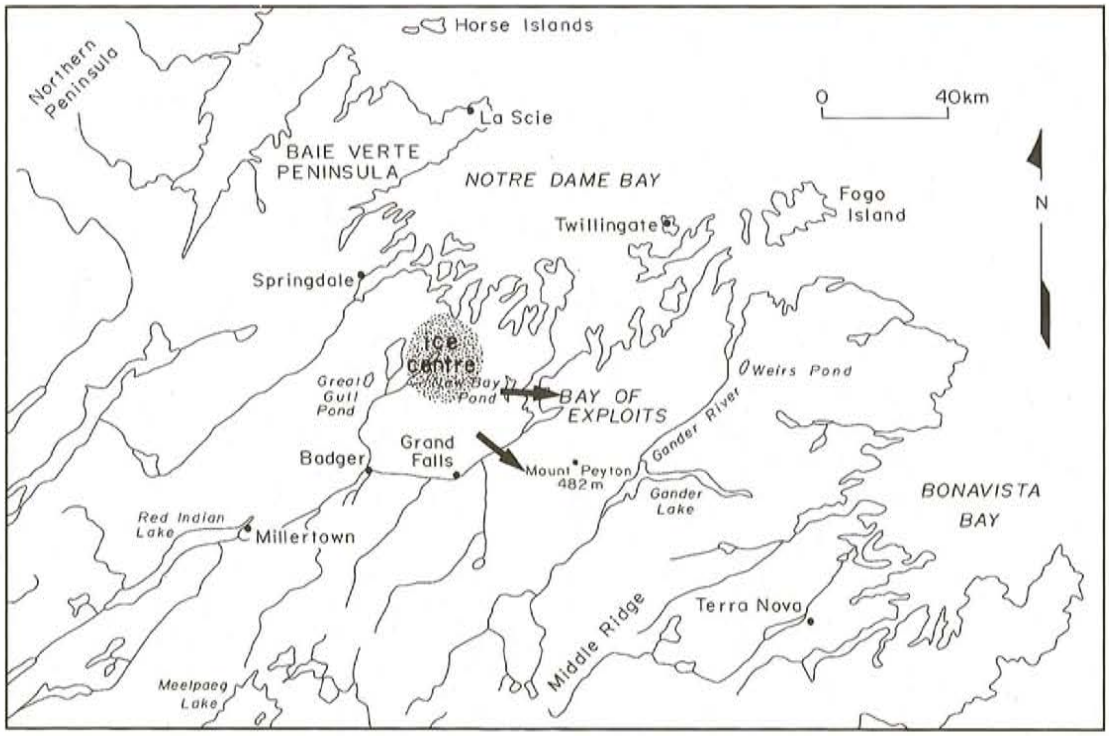

Figure 6. *Fourth ice-flow event.*

4) final decay of the central Newfoundland ice cap resulted in minor ice centres, which may have briefly readvanced, possibly as a result of cooling during the Younger Dryas.

IMPLICATIONS FOR DRIFT PROSPECTING

An understanding of the ice-flow history for this region will aid mineral exploration in interpreting the dispersion of mineralized float and geochemical anomalies in Quaternary sediments. In general, the most recent flow is responsible for the dispersion of mineralized source material (Batterson and Vatcher, *this volume;* Liverman and Scott, 1990). However, where multiple flows have been identified, dispersion by earlier flows should be considered (Proudfoot *et al.*, 1990). It is possible that the earlier east-southeast ice flow could initally have dispersed sediment that was subsequently reworked by the later north-northeast flows. Furthermore, most of the area has a thick drift cover (Liverman and Taylor, 1990) and it is possible that a complex till stratigraphy exists over parts of the region. In such cases, provenance and thus the geochemistry of each till sheet will differ, therefore, care must be taken in sampling.

CONCLUSION

This new ice-flow data from the Notre Dame Bay area, when combined with existing available data, adds to the comprehension of the glacial history of Newfoundland. Work being conducted in the offshore may substantiate whether ice from the Northern Peninsula did have an affect on the deglacial history of the Notre Dame Bay area. The model for deglaciation presented here will be tested over the coming field seasons by further mapping to check its validity.

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