*Current Research (2000) Newfoundland Department of Mines and Energy*
*Geological Survey, Report 2000-1, pages 61-67*

# TILL GEOCHEMISTRY IN THE HODGES HILL AREA

D. Taylor and D. Liverman
Geochemistry, Geophysics and Terrain Sciences Section

## ABSTRACT

*Mapping of the surficial geology in the Hodges Hill area shows a strong regional north to northeast ice-flow regime. An early eastward ice-flow and a later local east-southeastward flow were identified, although they appear to have had little affect on the regional till geochemical dispersal patterns.*

*Till cover is extensive inland, generally greater than 1 m, whereas the coastal areas are dominated by marine and glaciomarine sediments. This hampered geochemical exploration in the area due to the possible reworking of the sediments by marine processes below 75 m asl.*

*A regional till geochemical sampling program collected about 1100 samples from surficial sediments taken from below the B-soil horizon where possible. Geochemical data derived from the samples collected during the 1999 field season will be open-filed in late 2000.*

## INTRODUCTION

The Hodges Hill area is a region of significant mineral exploration interest, especially for gold and base metals. Regional surficial mapping (Liverman and Taylor, 1990) shows the area to contain a thick overburden, and this, coupled with a lack of ice-flow data, may be an impediment to successful mineral exploration efforts. A thorough understanding of the ice-flow history could enhance efforts to trace geochemical anomalies detected in the overburden to potential target areas. During the 1999 field season, the surficial geology was mapped and about 1100 till samples were collected for geochemical analyses in the area between Grand Falls in the south, and Fortune Harbour to the north. This program will fill a gap in the geochemical data coverage between areas to the south (Batterson and Taylor, 1998), east (Batterson and Vatcher, 1991), and the west (Sparkes, 1984; Klassen, 1994; Liverman *et al.*, 1995).

### LOCATION AND ACCESS

Field work was conducted over six, 1:50 000-scale NTS map areas located in central Newfoundland (Figure 1): Botwood (NTS 2E/3) north of the Trans-Canada Highway, Hodges Hill (NTS 2E/4), Robert's Arm (NTS 2E/5) southeast corner, Point Leamington (NTS 2E/6), Exploits (NTS 2E/11) and fill-in sampling on the east half of Dawes Pond (NTS 12H/1) (Figure 2). Access to much of the area was by truck or all-terrain vehicle through an extensive network of logging roads and paved highways. Helicopters were used to access remote areas.

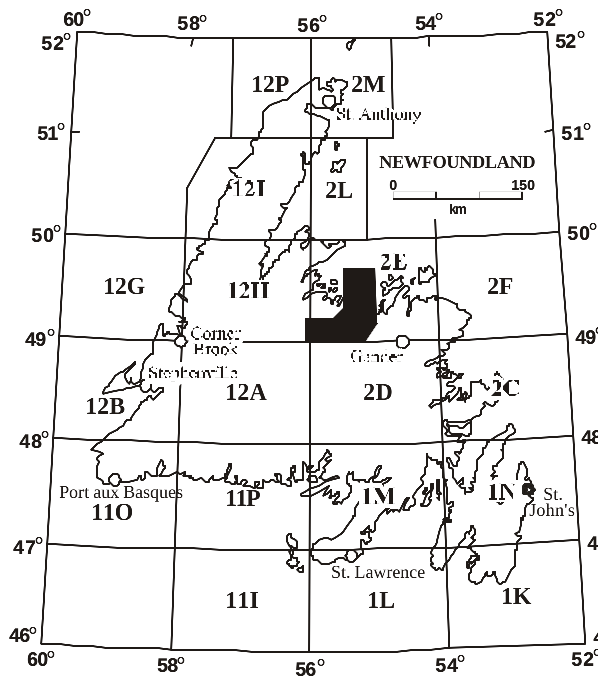


**Figure 1.** *Location map.*

### PREVIOUS WORK

Regional ice-flow patterns have been previously outlined by Lundqvist (1965), Rogerson (1982), Grant (1989) and St. Croix and Taylor (1991). In all cases, the ice-flow patterns are from the late Wisconsinan glacial period.

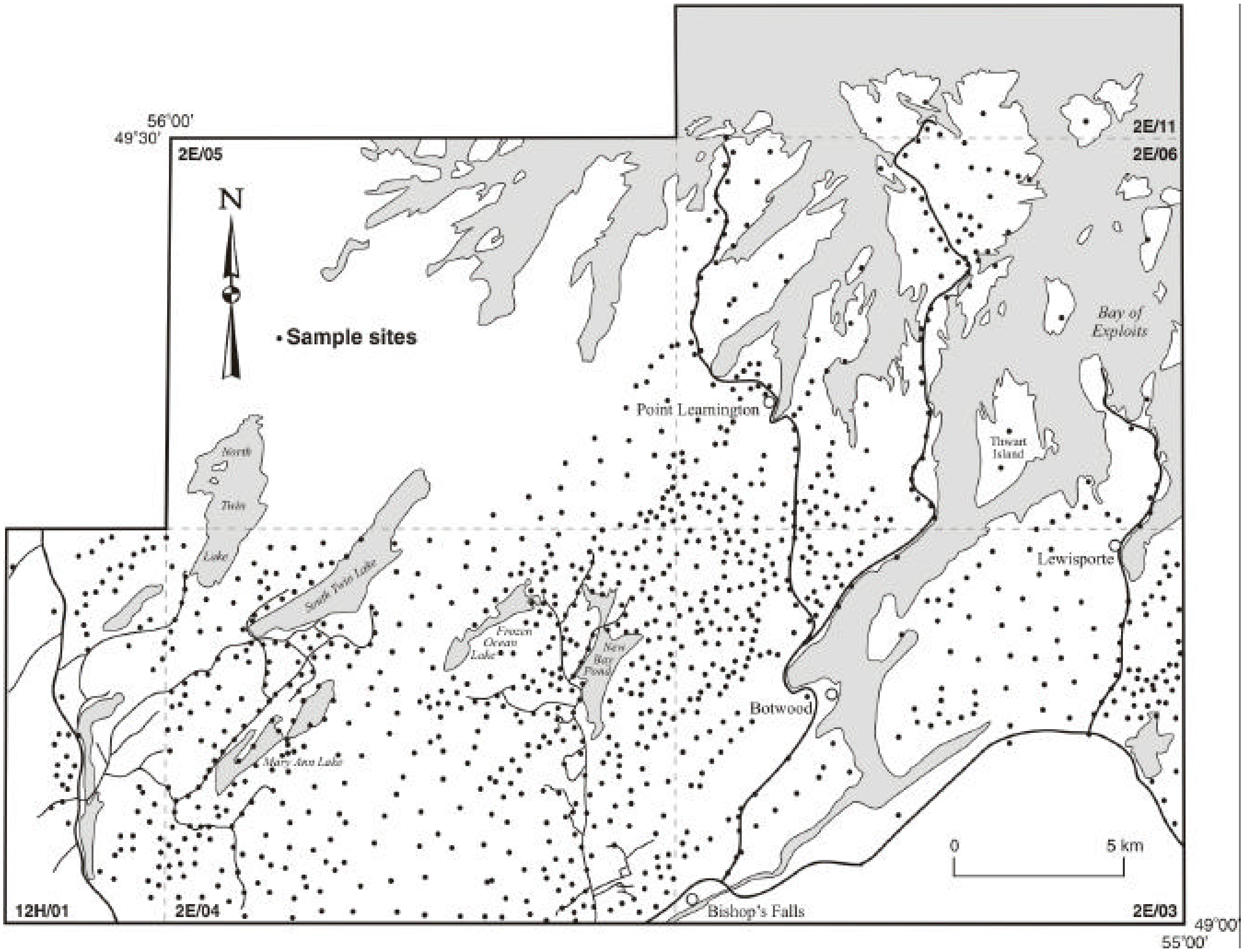


**Figure 2.** *Sample site location map.*

Lundqvist (1965) examined striations over a wide area of north–central Newfoundland and suggested that major ice flow was generally northeastward. Considerable local variation in flow direction was suggested to be due to the effects of local topography during deglaciation. Radial flow from an ice accumulation centre in the region of The Topsails has been described by Rogerson (1982) and Grant (1989). St. Croix and Taylor (1991) and Liverman (1992) postulated a four-phase sequence of deglaciation to explain a complex pattern of ice movement. They stated that, at the glacial maximum, ice that flowed from central Newfoundland was deflected to the east due to coalescence with ice from the Long Range Mountains along the coast of Notre Dame Bay. Retreat of Long Range Mountain ice resulted in northeastward flow from an ice divide located in the central Newfoundland uplands. As deglaciation progressed, a number of smaller remnant ice caps developed. A minor ice cap in the Twin Lakes area was identified in the final stages of deglaciation (St. Croix and Taylor, 1991). O'Donnel (1973) studied boulder trains originating from the Gullbridge mine site, and postulated two ice-flow phases of the same advance, an earlier northeastward flow shifting to a later northwestward movement.

Hornbrook *et al.* (1975) discussed the results of a pilot geochemical project in the New Bay Pond area (the southeastern part of NTS 2E/5), and concluded that soil and upper till sampling were less effective than basal till sampling in identifying bedrock mineralization. Grant (*in* Hornbrook *et al.*, 1975) described the surficial geology of the New Bay Pond area when the ice flow, (as indicated by striations and ice sculpted bedrock), was dominantly north-northward, with a later eastward ice flow.

Features and sediments indicating raised postglacial sea level have been widely identified in northeast Newfoundland (Richards 1940; MacClintock and Twenhofel, 1940; Lundqvist 1965; Tucker 1973, 1974; Scott *et al.*, 1991).

Marine limit, identified from the top of delta forsets, decreases from 75 m asl in the west (Tucker, 1974) to 58 m asl in the east (Mackenzie and Catto, 1993). Barnacles collected from marine clays near South Brook by D.R. Grant gave a radiocarbon date of 12 000 ± 220 BP (GSC-1733). *Mya truncata* and *Hiatella arctica* shells collected from the same area by C.M. Tucker were dated at 11 000 ± 190 BP (GSC-2085), and were interpreted as representing a minimum date for deglaciation and dating delta formation (Tucker, 1974; Lowdon and Blake, 1975). Scott *et al.* (1991) dated fossils (10 km inland of the Springdale delta) at between 11 300 BP ± 120 BP (GSC-5140) and 12 470 ± 380 BP (TO-2305). Scott *et al.* (1991) suggested that the highest deltas thus probably pre-dated 12 470 BP and also identified small deltas at 50 m asl in the South Pond valley, representing a still-stand in sea-level fall.

Macpherson (*in* McNeeley and McCuaig, 1991) reported a radiocarbon date of 12 000 ± 130 BP on gyttya from Gull Pond on Little Bay Island at 52 m asl, which was interpreted as marking the isolation of the lake from marine influence. A second date of 10 900 ± 160 (GSC-4636) was reported from Triton Island at an elevation of 23 m asl, and was also interpreted as showing isolation of the lake basin as sea levels fell (Macpherson, *in* McNeeley and McCuaig, 1991). However, the absence of pollen reflecting the Younger Dryas climatic cooling event suggests that these dates may be anomalously old through contamination (J. Macpherson, Department of Geography, Memorial University, personal communication, 1992).

Macpherson and Anderson (1985) reported the results of dating and pollen analysis from a core taken from Leading Tickles. Two radiocarbon dates were obtained from the core, a basal date of 13 200 ± 300 BP (GSC-3608), and a 10 500 ± 140 BP date from 20 cm above the basal date (GSC-3610). The results of pollen analysis are interpreted as showing an initial colonization by vegetation commencing around 13 200 BP in response to development of a favourable climate, followed by a cooling period lasting up to 10 500 BP. Following this date, major postglacial warming led to the development of tall-shrub tundra at the site. Anderson and Macpherson (1994) conclude that this climatic trend may be related to the Younger Dryas cooling event recognized widely around the North Atlantic.

### METHODS

A sampling program was carried out over till-covered areas as determined by surficial mapping. Sample spacing was 1 km over areas with road access and 2 km in remote areas where helicopter support was required. This yields a nominal sample density of one sample per 2 to 4 $km^2$. Sampling, where possible, was mostly from the C-soil horizon from hand-dug pits 0.3 to 1.3 m deep. Where this was not obtainable, the BC-soil horizon was sampled. Most of the inland areas produced good-quality samples having overburden thickness generally greater than one metre. Sampling along the coast produced less than ideal samples because of shallow or no overburden, and the presence of marine sediments. Sampling below 75 m to 58 m above sea level was generally avoided due to the possibility of sediments being reworked by marine processes.

The orientation of glacial striations represents a record of ice-flow direction at the time of their formation. Ice-flow direction, where possible, was determined from the morphology of the bedrock surface using such features such as stoss and lee, nailhead striations, and miniature crag-and-tails. Sites that contained two or more striation directions were interpreted to be the result of either separate glacial advances or different ice-flow directions within one flow event. Relative age relationships between separate flows on multiple direction sites were determined by crosscutting features and lee-side preservation. Most emphasis was placed on ice-flow mapping with a view to supplementing existing mapping.

## RESULTS

### ICE-FLOW HISTORY

Data collected during the 1999 field season supports interpretations made by Batterson and Taylor (1998) and St. Croix and Taylor (1991) (Figure 3). Evidence for three ice-flow events was found. The earliest event trends eastward over the field area. Ice-flow indicators formed by this event are consistently preserved on the lee-side surfaces of outcrops that show one or more subsequent ice-flow events. This eastward ice flow is mainly observed in areas east of the Bay of Exploits. The second ice-flow event showed a consistent regional north to northeastward flow over the entire study area. The orientation of this event varies along its path, especially toward the coast, and probably reflects topographic control. Areas west of the Bay of Exploits show a northeast trend and areas east of the Bay of Exploits show a dominate northward ice flow. The third and most recent ice flow in the region, was a local, late-phase event. This east–southeast-trending event was recorded in the Frozen Ocean Pond area and extended southeast to the Mount Peyton area. This late ice flow is characterized by a fine overprint of striations over the regional north to northeastward flow.

### SURFICIAL GEOLOGY

The surficial geology and geomorphology of the area is variable, with a strong contrast between coastal areas and

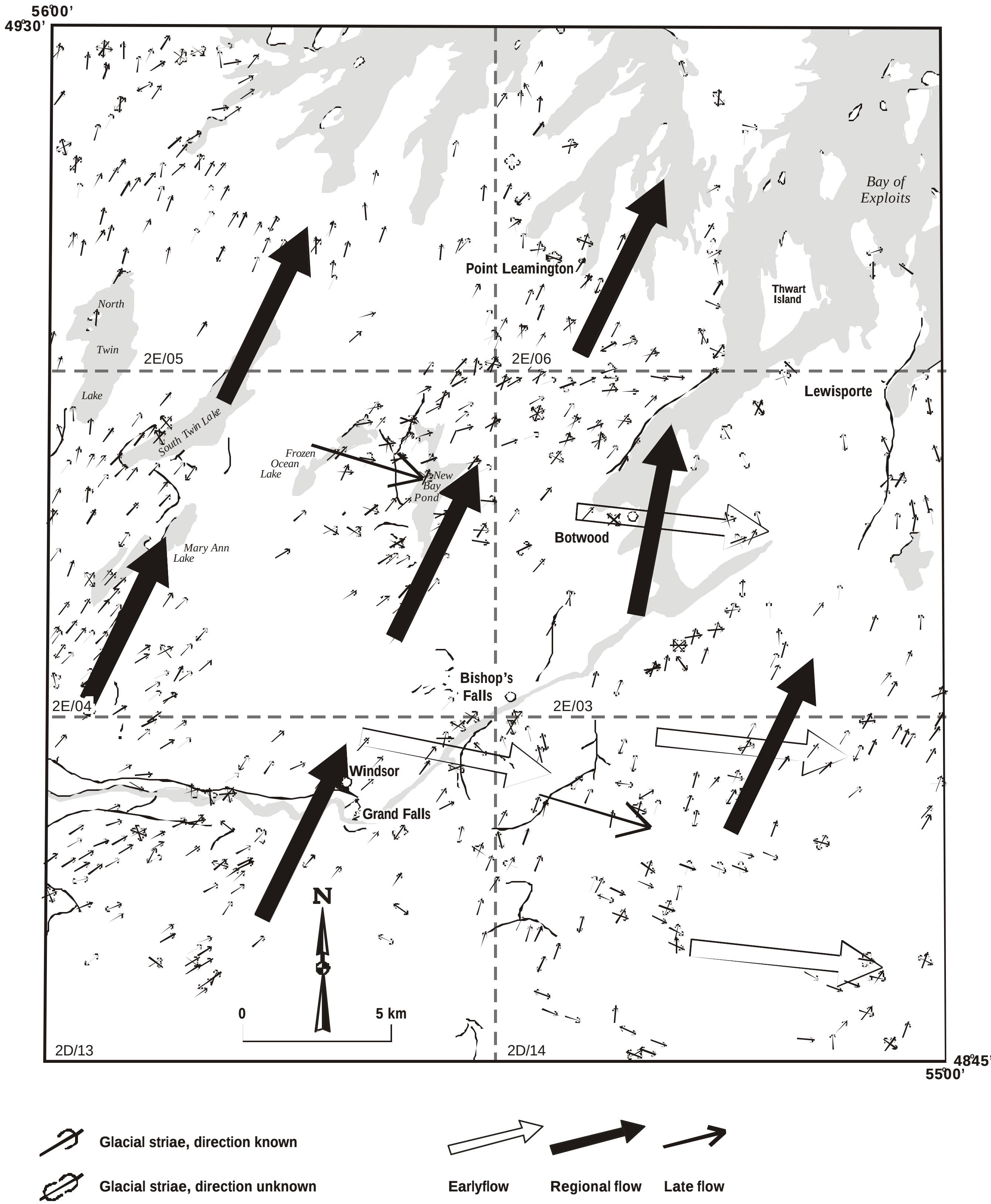


**Figure 3.** *Ice flow history of north-central Newfoundland.*

inland. The coast is mostly rock or rock concealed by a thin mat of vegetation, with a few gravel-dominated "pocket" beaches. In the coastal margin, extending up to 10 km inland, the topography is rugged, having mostly exposed or vegetated bedrock knobs interspersed with areas of bog and fen. Till is rare, and is restricted to small patches of till veneer. In small protected coves close to sea level, thick fossiliferous glaciomarine diamicton is sporadically found. This is commonly associated with gravels, deposited either in marine terraces, or as glaciofluvial deltas. Major deltas are located in the Botwood area and at other locations surrounding the Bay of Exploits. Marine shells were recovered at an elevation of 30 m asl near Indian Cove north of Point of Bay and 10 m asl close to the mouth of Western Arm Brook, west of Port Leamington. These will be submitted for radiocarbon dating.

Inland there is generally a thick surficial cover, with bedrock outcrop comparatively rare apart from around Hodges Hill. Till veneers are common on the flanks of Hodges Hill, and on other prominences. The central part of the area is dominated by wetland characterized by large areas of bog and ribbed fen. Many of the lowland areas in the south of the study area contain hummocky terrain, with the sediment mostly till. This indicates that these were areas of ice stagnation during deglaciation. Patches of eroded till, with many minor meltwater channels are common on hillsides, probably reflecting ice stagnation in the area. Till blankets cover the gentle topography in the north of the map area. Large gravel terraces are found adjacent to Peter's River, along Northern Arm Brook, and in the Bishops Falls area. These gravels are underlain by marine muds and sands, and often overlain by bog and fen.

## CONCLUSIONS

The pattern of sediment distribution and ice flow is consistent with previous interpretations of dominant ice flow from an ice centre located in central Newfoundland, likely in the The Topsails or Middle Ridge. Ice flow varied little in orientation from the last glacial maximum through deglaciation, with deviations mainly associated with topographic drawdown. It is likely that only evidence of the last (late Wisconsinan) glaciation are preserved. The areas of hummocky moraine suggest stagnation of ice around Twin Lakes and southeast of Hodges Hill. This may be associated with the late-glacial ice centre proposed by Grant (1974) in this area.

Much of the coastal part of the study area was covered by the sea following deglaciation as shown by the common occurrence of marine fossils above modern sea level. The chronology of sea-level change is uncertain. The marine limit in the area is between 75 and 58 m asl, decreasing to the east, and this occurred prior to 12 400 BP. By 10 000 BP sea level fell below present, reaching a minimum of −17 m asl in the Bay of Exploits by about 8000 BP (Shaw and Edwardson, 1994). Sea level is likely currently rising.

## IMPLICATIONS FOR DRIFT PROSPECTING

The ice-flow history is dominated by the regional north to northeastward flow. Dispersal distances of clasts associated with this flow appear to be in the order of kilometres, rather than metres, due to consistent ice-flow trends throughout much of the last glaciation. Dispersal trains are likely to be ribbon shaped (*cf*. O'Donnel, 1973). It is likely that dispersal distances will differ between the areas of hummocky moraine, and those of till blankets. Hummocky moraine forms in a stagnation environment, and likely contains a great proportion of supraglacial (and more far travelled) debris than basally deposited till.

Use of till as a sampling medium for geochemical exploration is restricted to 58 to 75 m asl. Most diamictons in low-lying coastal areas are glaciomarine rather than glacial, as shown by the common occurrence of fossils, and conventional drift-prospecting methods cannot be applied in these areas. Sampling of residual soils is a possible alternative, although such samples likely represent only very local bedrock composition. Sampling of stream or overbank sediment may be a more fruitful approach. Further inland, till sampling will be more successful due to the combination of good sampling media, and a dominant regional ice flow.

## ACKNOWLEDGMENTS

The authors thank the following for their contributions to the project. Danny O'Dell, Jennifer Smith, Mark Osmond and Kevin Sheppard provided enthusiastic field assistance. Joyce Wheaton is thanked for her superb job in keeping the crew well fed. Martin Batterson is thanked for reviewing this manuscript.

## REFERENCES

Anderson, T.W. and Macpherson, J.B.
1994: Wisconsinan late glacial environmental change in Newfoundland: a regional review. Journal of Quaternary Science, Volume 9, pages 171-178.

Batterson, M. and Taylor, D.
1998: Surficial geology and geochemical sampling in the Grand Falls to Glenwood areas. *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 98-1, pages 1-8.

Batterson, M. and Vatcher, S.
1991: Quaternary geology of the Gander (NTS 2D/15 map area). *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 91-1, pages 1-12.

Grant, D.R.
1974: Prospecting in Newfoundland and the theory of multiple shrinking ice caps. Geological Survey of Canada, Paper 74-1, Part B, pages 215-216

1989: Quaternary geology of the Atlantic Appalachian region of Canada. *In* Quaternary Geology of Canada and Greenland. *Edited by* R.J. Fulton. Geological Survey of Canada, Geology of Canada no. 1, pages 391-440.

Hornbrook, E.H.W, Davenport, P.H. and Grant, D.R.
1975: Regional and detailed geochemical exploration studies in glaciated terrain in Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 75-2, 116 pages.

Klassen, R.A.
1994: Till geochemistry and ice flow data, central Newfoundland. Geological Survey of Canada, Open File 2823, 350 pages.

Liverman D.G.E.
1992: The application of regional surficial geology mapping to mineral exploration, northeastern Newfoundland, Canada. Transactions of the International Association of Mining and Metallurgy, Section B, 101, pages B89-98.

Liverman, D.G.E. and Taylor, D.M.
1990: Surficial geology maps for the Island of Newfoundland. 10 maps, scale 1:250,000. Newfoundland Department of Mines and Energy, Geological Survey of Newfoundland, Open File maps NFLD (1904).

Liverman D.G.E., Taylor, D., Maunder, J. and Benson, L.
1995: Quaternary mapping, Robert's Arm, Little Bay Island and Springdale areas (NTS 2E/5, 2E/12 and 12H/8). *In* Current Research. Newfoundland Department of Natural Resources, Geological Survey, Report 95-1, pages 113-125.

Lowdon, J.A. and Blake, W.
1975: Geological Survey of Canada Radiocarbon Dates XV. Geological Survey of Canada, Paper 75-7. 31 pages.

Lundqvist, J.
1965: Glacial geology in northeastern Newfoundland. Geologiska Foreningen i Stockholm Forhandlingar, Volume 87, pages 285-306.

MacClintock, P. and Twenhofel, W.H.
1940: Wisconsin glaciation of Newfoundland. Bulletin of the Geological Society of America, Volume 51, pages 1729-1756.

Mackenzie, C. and Catto, N.R.
1993: Quaternary geology of the Botwood (NTS 2E/3) map area. *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey of Newfoundland, Report 93-1, pages 139-148.

Macpherson, J.B. and Anderson, T.W.
1985: Further evidence of late glacial climatic fluctuations from Newfoundland: pollen stratigraphy from a north coast site. *In* Current Research. Geological Survey of Canada, Paper 85-1B, pages 383-390.

McNeeley, R. and McCuaig, S.
1991: Geological Survey of Canada Radiocarbon Dates XXIX. Geological Survey of Canada, Paper 89-7, 134 pages.

O'Donnel, N.D.
1973: Glacial indicator trains near Gullbridge, Newfoundland. Unpublished M.Sc. thesis, Department of Geology, University of Western Ontario, 258 pages.

Richards, H.G.
1940: Marine Pleistocene fossils from Newfoundland. Bulletin of the Geological Society of America, Volume 51, pages 1781-1788.

Rogerson, R.J.
1982: The glaciation of Newfoundland and Labrador. *In* Prospecting in Areas of Glaciated Terrain - 1982. *Edited by* P.H. Davenport. Canadian Institute of Mining and Metallurgy, pages 37-56.

Scott, S., Catto, N.R. and Liverman, D.G.E.
1991: Sedimentology of Quaternary marine sediments in the Hall's Bay area, Newfoundland. Atlantic Geology, Volume 27, pages 181-191.

Shaw, J. and Edwardson, K.A.
1994: Surficial sediments and post-glacial sea-level history, Hamilton Sound, Newfoundland. Atlantic Geology, Volume 30, pages 121-127.

Sparkes, B.G.
1984: Surficial and glacial geology, central Newfoundland, including geochemistry of till samples for Victoria Lake (12A/6), Snowshoe Pond (12A/7) and Star Lake (12A/11), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Open File 012A/0347.

St. Croix, L. and Taylor, D.M.
1991: Regional striation survey and deglacial history of the Notre Dame Bay area. *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey of Newfoundland, Report 91-1, pages 61-68.

Tucker, C.M.
1973: The glacial geomorphology of west-central Newfoundland; Halls Bay to Topsails. Unpublished M.Sc. thesis, Department of Geography, Memorial University, Newfoundland.

1974: A series of raised Pleistocene deltas in Halls Bay, Newfoundland. Maritime Sediments, Volume 10, pages 1-7.