Current Research (1996) Newfoundland Department of Natural Resources,
Geological Survey, Report 96-1, pages 1-10

QUATERNARY GEOLOGY OF PARTS OF THE CENTRAL AND SOUTHERN HOPEDALE BLOCK, LABRADOR[1]

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ABSTRACT

During the Late Wisconsinan, the Hopedale Block south of the Adlatok River in central Labrador, was completely ice covered. Ice flow during the Late Wisconsinan, and possibly during earlier phases of flow, was toward the northeast. Some local variation in direction was found, especially near the coast, but in all cases such variations were parallel to the major bays, down which ice flow was presumably drawn.

Much of the area is dominated by bedrock outcrop having a thin and discontinuous till cover. The exceptions are the major river valleys that contain thick deposits of gravel, sand and mud, of fluvial, glaciofluvial or marine origin. Marine limit in the study area is about 125 m asl. Most areas below this were covered by higher sea levels immediately following deglaciation. However, some areas below marine limit may have remained ice covered and were not invaded by the sea. Florence Lake, for instance, lies at an elevation below marine limit, but contains no marine sediments. Therefore, this valley may have contained glacier ice during the early stages of higher relative sea levels, and only became ice free after the sea level had dropped to below the level of the outlet.

Over the till covered areas, glacial dispersal patterns (identified by conventional drift-exploration techniques) are relatively simple, with dispersal trains linear toward the northeast. Drift exploration within the major valleys requires the consideration of a fluvial system, where dispersal may be unrelated to ice-flow directions, and transport distances may be much greater. Dispersal in this case is down-stream rather than down-glacier. Drift-exploration programs in these areas should be undertaken with caution. Areas below marine limit commonly contain marine muds and nearshore sand and gravel. These sediments have been transported down stream into a marine environment, where they have been subsequently reworked. Also, material may have been contributed by icebergs from sources well outside the local area. Geochemical or geophysical anomalies in areas below marine limit may be unrelated to any mineralization. Drift-exploration programs in these areas should be avoided.

INTRODUCTION

This project is a surficial geology survey, and is one component of the multi-disciplinary project of the provincial Geological Survey in the Hopedale Block south of the Adlatok River in central Labrador (Figure 1). Other parts of the study included a bedrock mapping project (see James *et al., this volume*), a mineral deposits study (Miller, *this volume*), and a geochemical survey focusing on greenstone belts in the Florence Lake area (see McConnell, *this volume*). The Quaternary geology component involved surficial mapping from 1:50 000-scale aerial photographs, field checking of map units, mapping the regional ice flow, and describing the Quaternary history of the area. Attention was paid to areas suitable for conventional drift-prospecting surveys (e.g., till geochemistry and boulder tracing) in regional mineral exploration programs. Areas where these strategies could not be applied, including those areas inundated by a higher sea level at the end of the last glacial period, were also identified. The field component of the project was completed in three weeks between late June and early July, 1995.

LOCATION

The study area is about 3800 km^2, and encompasses all or parts of five 1:50 000 NTS map sheets (13K/14, 13K/15, 13N/1W, 13N/2, 13N/3), between 54°45' N and 55°15'N, and 60°15'W and 61°30'W. The field camp was located at the southern end of Florence Lake, Labrador, about 175 km north of Goose Bay. Access was by float plane from Goose Bay, although the indented coastline allows boat access to the northern part of the area. A helicopter was used during field work.

[1] Hopedale multidisciplinary project: Quaternary geology

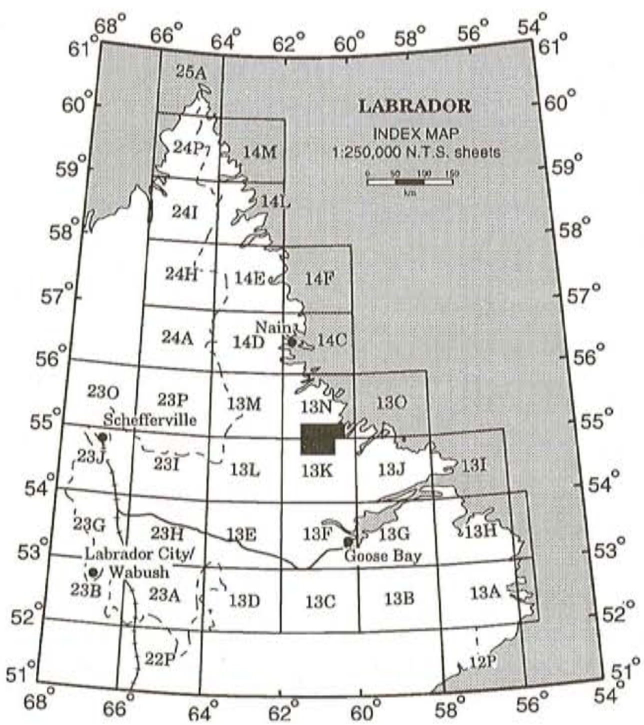


Figure 1. *Location of field area.*

PHYSIOGRAPHY

The area is drained by three river systems. The Kanairiktok River in the south, flows through a flat valley up to 10 km wide and enters the ocean at Kanairiktok Bay (Figure 2). The valley floor lies below 115 m elevation in the study area, and contains sandy fluvial terraces on both sides of the river. The terraces have been incised by tributaries, and eroded by the Kanairiktok River; the contact with the terraces and the bedrock of the valley sides is commonly sharp. There are some bedrock exposures on the valley floor, especially at the site of rapids. The Kanairiktok River is separated from tributaries of Ugjoktok River to the north by a low col at about 85 m asl. The Ugjoktok River system drains the central part of the study area, including Florence Lake, and empties into Ugjoktok Bay. The northern part of the area, including Shapio Lake and Mistinippi Lake, is drained by the Adlatok River. It enters the sea at Adlatok Bay, although the main southern branch cuts through a narrow channel into Ugjoktok Bay. The Adlatok River valley contains thick sequences of sand and gravel exposed in several terrace surfaces (Plate 1). Terraces were found at about 125, 105, 100, 85, 75, and 55 m asl, and record periods of falling relative sea level following deglaciation. North of the Adlatok River valley the terrain is rugged, with individual peaks reaching elevations up to 340 m asl. Glacial sediment is thin and discontinuous in this area. At the coast and between Adlatok and Ugjoktok bays, and Ugjoktok and Kanairiktok bays, the terrain is bedrock dominated, although marine terraces are found in areas close to modern sea level.

The area between the Adlatok and Kanairiktok river valleys, east of Mistinippi Lake has a subdued topography. Uplands are commonly bedrock dominated, although overburden is thicker and more continuous than the area to the north. Lowlands are commonly filled with shallow lakes and have margins covered with large angular boulders, mostly of local provenance, commonly 2 to 5 m diameter. Major drainage routes, such as the valleys that contain Stomach Lake, English Lake, and Florence Lake commonly contain eskers.

BEDROCK GEOLOGY

The study area is mostly underlain by Middle to Late Archean rocks of the Nain Structural Province, except for east of the Kanairiktok River, which is underlain by rocks of the Makkovik sub-province. The following summary is mainly taken from Ermanovics (1993), although subsequent work by Miller (*this volume*) and James *et al.* (*this volume*) has superseded this mapping in selected areas.

The northern part of the area, north of the Adlatok and Shapio Lake valleys is underlain by migmatite, mostly a mixture of gneissic and plutonic rocks. The Kanairiktok Plutonic Suite intrudes the migmatites and dominates much of the rest of the study area. It consists of medium- to coarse-grained, calc-alkaline, biotite–hornblende-bearing, grey to pink tonalite and granodiorite having minor amounts of pink granite.

The Florence Lake Group occupies the area around Florence Lake, between Stomach Lake and English Lake, west of Ugjoktok Bay, and between Adlatok Bay and Ugjoktok Bay. The group consists of felsic and siliceous greywacke (Lise Lake Formation), intermediate greywacke (Adlatok Formation), and mafic volcanic rocks, mostly layered flows and sills (Schist Lakes Formation). Most rocks of the Florence Lake Group are northeast trending. They are in tectonic contact with migmatites and are intruded by northeast-trending sheets of the Kanairiktok Plutonic Suite. The whole study area is dissected by diabase and gabbro dykes.

Potential significant mineralization occurs within the Florence Lake Group. Pyrite–pyrrhotite–chalcopyrite are the common mineral assemblages found as stratabound units. Malachite-stained chalcopyrite–pyrite-bearing quartz veins occur within greywacke and felsic rocks. The Baikie showing, northeast of Florence Lake, has been the focus of recent exploration by Falconbridge Exploration, and also has platinum-group-element potential.

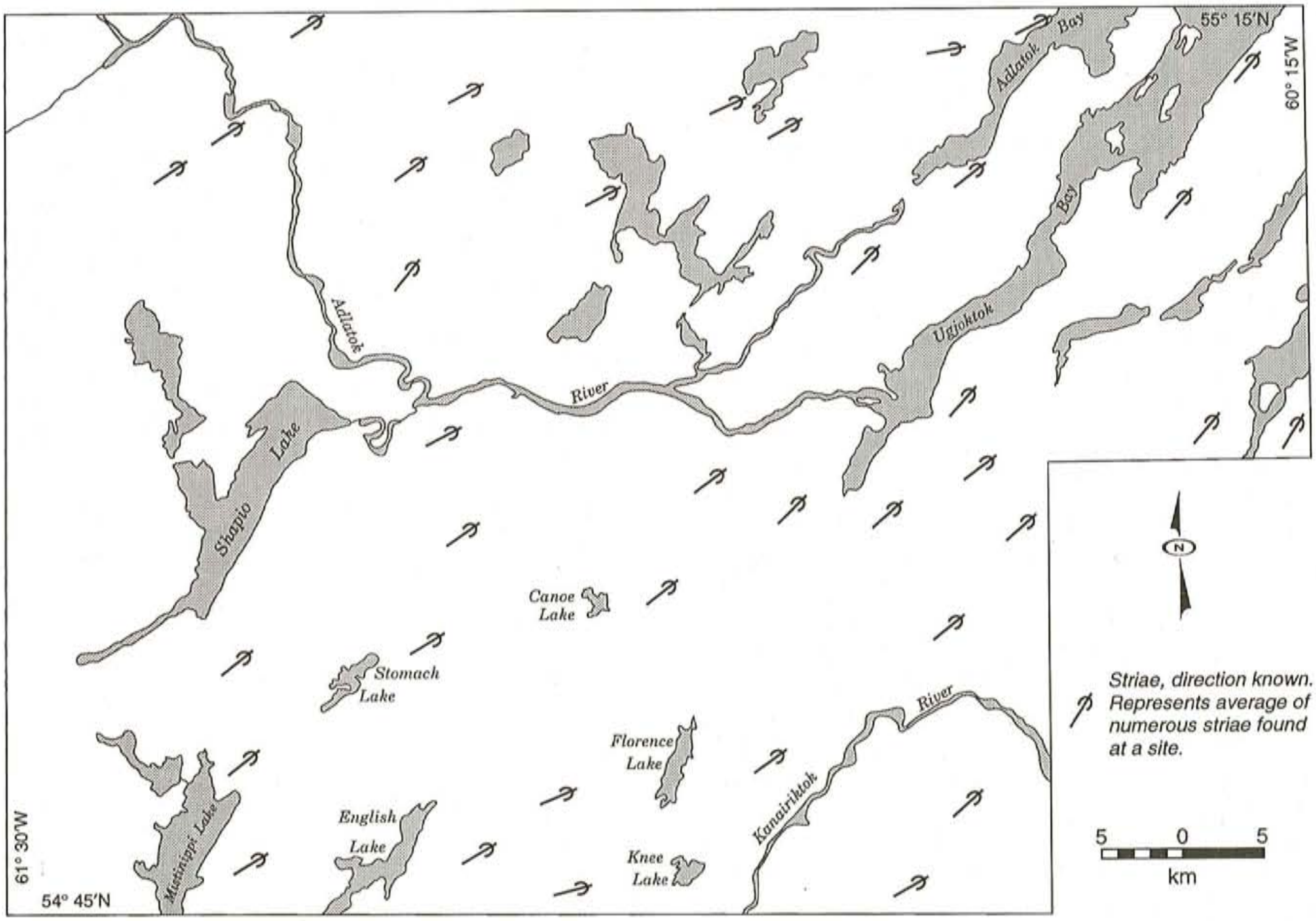


Figure 2. *Ice-flow directions within the study area.*

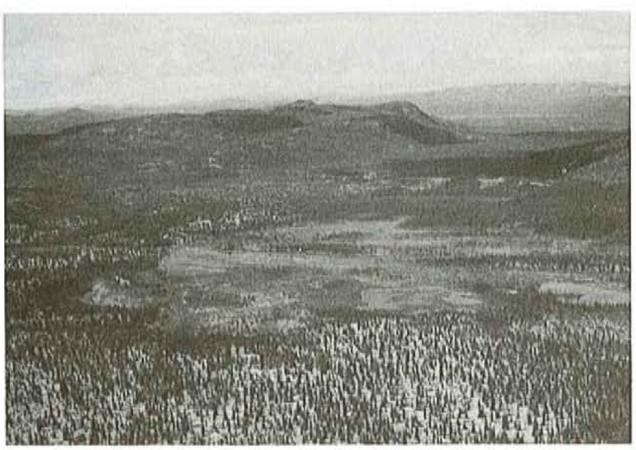


Plate 1. *View of the Adlatok River valley. The surrounding uplands are commonly bedrock dominated, whereas the valley floor is filled with postglacial marine and fluvial sediments. A raised marine delta with a prominent front is seen in the middle background. The marine limit in this area is about 125 m asl.*

None of the rock types in the study area were suitable for use in glacial dispersal studies because of their wide distribution and lack of visual distinction.

PREVIOUS WORK

Quaternary mapping and till geochemistry surveys have been completed at the regional and local scale over the eastern Central Mineral Belt, as part of the 1984-1989 Canada – Newfoundland Mineral Development Agreement. At the regional level, Klassen and Thompson (1988, 1989, 1993) and Thompson and Klassen (1986) described the ice-flow and glacial-dispersal patterns, and Thompson *et al.* (1986) provided the till-geochemistry data. Although the local bedrock geology is unsuitable for clast-dispersal studies, the area falls within several regional-scale glacial dispersal trains from bedrock sources in the Seal Lake Group, Bruce River Group, Snegamook granite and Red Wine complex. Each of these trains has a general northeastward trend, consistent with observed erosional ice-flow indicators. Klassen *et al.* (1991) have completed a 1:1 000 000-scale glacial landforms and deposits map for Labrador.

At the local level, Batterson *et al.* (1987, 1988) provided surficial mapping and glacial dispersal data for NTS map area 13J/12, 13K/7, 13K/9, and 13K/10, south of the present study area. Batterson (1991a, and b) presented results of till-geochemistry surveys from the same area.

METHODOLOGY

This study was a reconnaissance-mapping project aimed at providing a regional Quaternary geology framework for future mineral exploration. Preliminary work included mapping from 1:50 000-scale black and white aerial photographs. These findings were checked during an intensive three-week field program with limited helicopter support. Hilltops were the preferred sampling location because of their ease of access, and their potential for indicating regional, rather than local, ice-flow patterns. In doing so, it is realized that local glacial flows, perhaps in response to topographic changes as demonstrated by Batterson *et al.* (1987, 1988) for the Moran Lake and Melody Lake areas, may have been overlooked. At each site visited, the orientation of ice-flow indicators (mostly striations) was recorded, and a sample of surficial sediment (usually from frost boils) was taken for till geochemistry. Within valleys, the distribution and types of Quaternary sediment were noted, and in some places areas of potential marine influence were examined. Samples of marine macrofauna were collected where found. A total of 56 sites were examined, 43 sets of striations were measured, and 42 samples submitted for till geochemistry.

All data from this project will be released in a digital format.

ICE-FLOW HISTORY

Ice flow is indicated by erosional and depositional features. Erosional features include striae, nailhead striae, and small (less than 1 m diameter) and medium (1 to 10 m diameter) sized rôches moutonées (Plate 2). Depositional features include erratic clasts, and crag-and-tail hills. All these features were generally consistent in their orientation across the study area. Forty-three single direction sites were examined ranging from azimuth 035 to 075°, with most between 040 and 060°. In no case was more than one ice-flow direction recorded at a site (Figure 2).

Depositional features are rare. Several northeastward-oriented crag-and-tail hills were found in the Adlatok River valley. Erratic clasts are common on hilltops, although they compose less than 1 percent of the total clasts exposed. Identified rock types included red sedimentary rocks (Seal Lake Group?); pink, coarse-grained granite (Snegamook granite); and green amygdaloidal volcanic rocks (Seal Lake and Bruce River groups). The source areas for these clasts is southwest of the study area, and is consistent with north-eastward glacial transport.

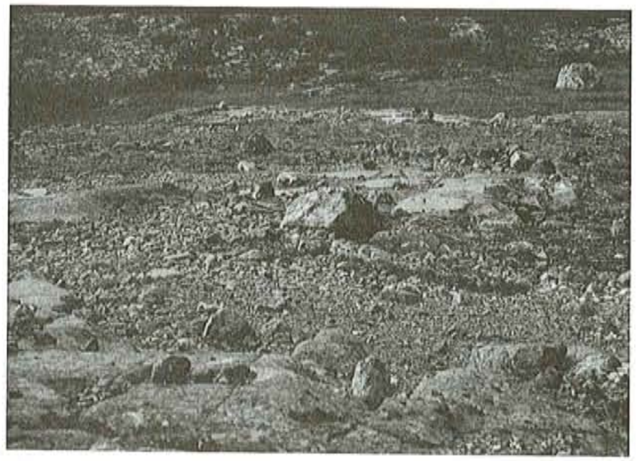


Plate 2. *Stossed bedrock surfaces north of Adlatok River. Exposed bedrock surfaces, commonly stossed to the northeast, and covered by a discontinuous veneer of till is typical of many upland areas in the Hopedale Block area.*

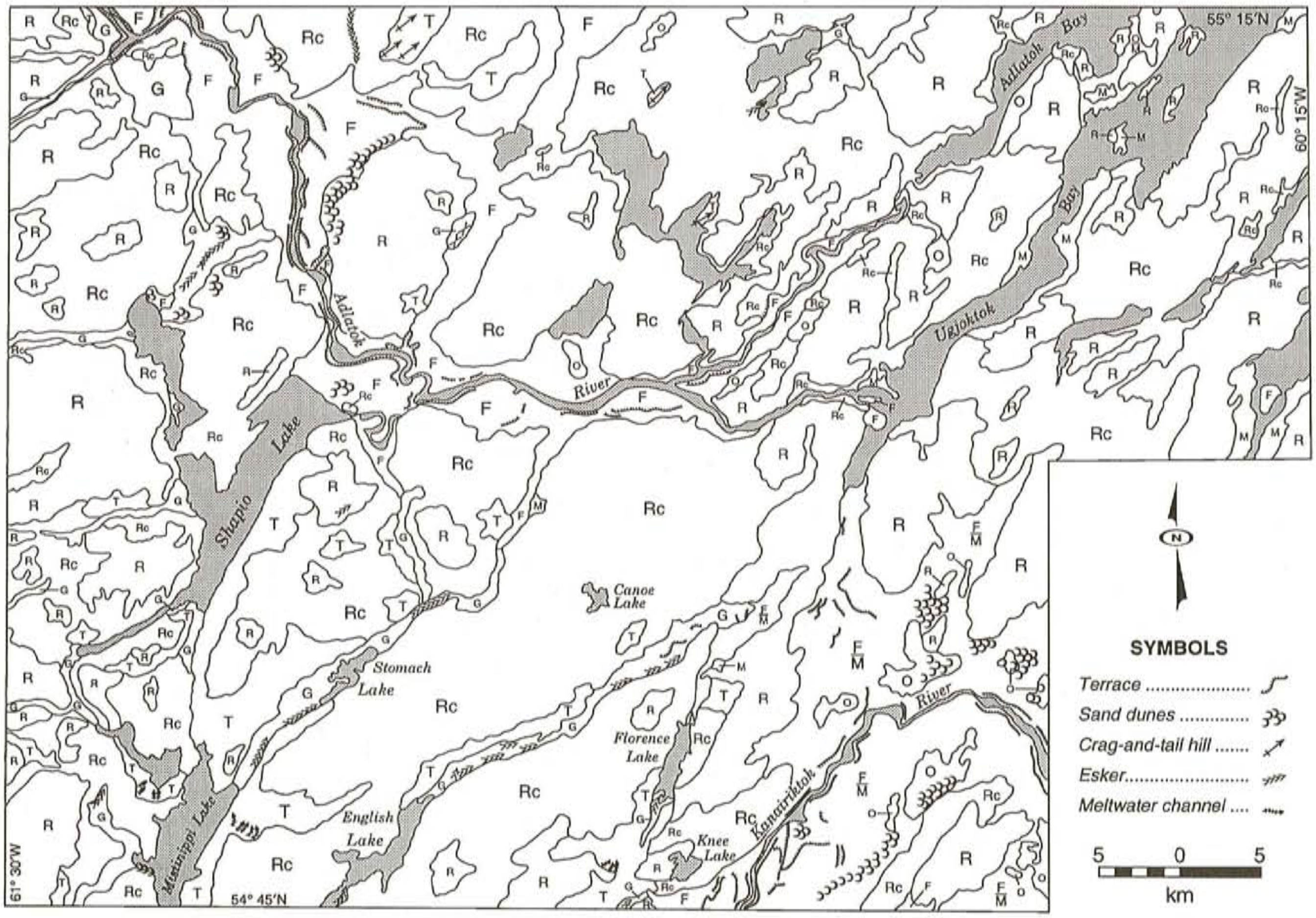
In general, ice-flow indicators are aligned parallel to bedrock structure. In the area around Florence Lake, ice flow was parallel to rock ridges, whereas toward the coast, flow was parallel to foliation in gneiss. Stossed bedrock surfaces are common across the area. At the coast, the orientation of the major bays, including Adlatok, Ugjoktok and Kanairiktok bays, is parallel with the trend of regional ice movement. These bays were likely major conduits for glacier ice.

SURFICIAL GEOLOGY

The following are brief descriptions of the distribution of surficial geology units found in the study area (Figure 3). This was mostly derived from aerial photograph interpretation, with a limited amount of field ground checking. The use of individual surficial units in drift-prospecting programs is also discussed.

BEDROCK

The major unit within the study area is either exposed bedrock surfaces or bedrock concealed by a thin mat of vegetation or sediment (Figure 3). Bedrock structure is commonly oriented northeast – southwest, defined by low-relief bedrock ridges. Other areas, particularly those underlain by igneous rock types are more massive and are exposed as rock knobs.



LEGEND

Postglacial

O **Organic** – *Accumulations of organic matter deposited in poorly drained areas; commonly underlain by till or bedrock*

F **Fluvial** – *Sediment 1- to 10-m-thick composed of planar and crossbedded, moderately and well-sorted sands and gravels; especially common in Adlatok and Kanairiktok river valleys*

M **Marine** – *Sediment 1- to 30-m-thick composed of poorly to well-sorted sands and gravels, and rhythmically bedded silts and clays; includes marine terraces and deltas; marine sediments are commonly overlain by fluvial sands and gravels*

Glacial

G **Glaciofluvial deposits** – *Sediment 1- to 30-m-thick composed of poorly to well-sorted sands and gravels; includes eskers within many of the larger valleys*

T **Till** – *Commonly a veneer (<2 m) of generally subglacial till of local provenance; may include relief features such as moraines; numerous bedrock exposures throughout unit*

Preglacial

Rc **Bedrock** – *Commonly concealed by a thin (<1 m) veneer of sediment or vegetation; includes small areas of exposed bedrock*

R **Bedrock** – *Exposed bedrock with little or no sediment or vegetation cover*

Figure 3. *Simplified surficial geology map of the study area.*

GLACIAL

Sediments loosely defined as till were noted across the study area at all elevations above about 115 m asl (Figure 2). Tills are generally thin (less than 2 m) and are discontinuous over bedrock-dominated areas north of the Adlatok River valley (Plate 2), and more continuous to the south. Within the study area, tills are stony, very poorly sorted to unsorted, with a sandy to silty matrix. They are generally structureless, and have a colour similar to the local bedrock, from which they were derived. On the hilltops, tills have been cryoturbated and frost boils are common. The surface of frost boils commonly exposed erratic clasts, although the clast assemblage is dominated by rock types of local provenance. Only single till units were observed during field work, although J. McConnell (personal communication, June 1995) noted 2 till units near Florence Lake. The upper unit was a thin (less than 50 cm) sandy till containing numerous erratics, whereas the lower unit was a thicker (greater than 50 cm), sandy to silty till containing clasts of local origin.

Tills form a featureless surface, except for several crag-and-tail hills in the Adlatok River valley. In many of the valleys, the till surface is covered by numerous large, angular boulders of local provenance. Similar boulder concentrations have been noted by Batterson *et al.* (1987) and Klassen and Thompson (1993). The boulders form a continuous cover and can be a serious impediment to ground traversing, as well as sampling programs.

Tills are the prime sampling medium in drift-exploration programs. They are composed mostly of local material, with few erratics, and are thus considered to be local in derivation. Most material is transported a short distance from its source (Shilts, 1982; Batterson, 1989) and the dispersal trains are linear, trending northeastward.

GLACIOFLUVIAL

Glaciofluvial sediments are those deposited by meltwater in glacially fed streams. They include sediments deposited subglacially (e.g., eskers) and proglacially. The sediments are poorly to well-sorted sand and gravel, commonly with rapid vertical and lateral variations in grain size. They commonly contain a high proportion of erratic clasts. The surface may be featureless, but more commonly is dissected by abandoned channels, pock-marked by roughly circular depressions (kettleholes) or contains sinuous esker ridges. Within the study area, glaciofluvial sediments, including eskers, are found in the Florence Lake, Stomach Lake and English Lake valleys, along the Adlatok River, and in the valleys feeding into the western shores of Shapio and Mistinippi lakes (Figure 3).

Glaciofluvial sediments are deposited by a glacier-fed fluvial system. The sediment is derived from the erosion of till, and transported through a river system in directions unrelated to glacier movement. The advantage is that fluvial systems remove fine particles, and preferentially concentrate the heavy mineral fraction, allowing recognition of indicator minerals that occur in minute quantities over an area (e.g., chrome diopside and pyrope garnets). However, transport distances are commonly larger than those for till. Drift-exploration programs in these areas should proceed with caution, although they have been used in many areas (Bolduc *et al.*, 1987; Lee, 1968; McClenaghan *et al.*, 1993; Ryan and McConnell, 1995). Combining results from till surveys with those from glaciofluvial sediment surveys should be avoided (Batterson, 1989).

MARINE SEDIMENT

Both proximal and distal marine sediments were found in the study area. Distal marine sediments were found in the Adlatok, Ugjoktok and Kanairiktok river valleys (Figure 3). The sediments were planar stratified, well sorted, very fine sand, silt and clay (Plate 3). Individual beds were 0.5 to 2.0 cm thick and normal graded. Muds were generally reddish brown in the Kanairiktok and Ugjoktok river valleys, and grey in the Adlatok River valley. The contrasting colour likely indicates a difference in source sediment. The reddish-brown muds were likely derived from source rocks in the Seal Lake and Bruce River groups found upstream of Snegamook Lake in the Kanairiktok River system. The similar coloured muds in the Ugjoktok River valley also indicates the valley was connected to the Kanairiktok River valley at some time in the early Holocene. Muds in the Adlatok River were derived from gneiss and anorthosite bedrock sources within and to the north of the Harp Lake area.

Marine fauna were found at two locations in the study area. Along the Adlatok River, marine molluscs (*Mesodesma arctatum*) were found at 55°13.21'N 61°17.24'W at 90 m asl. In the Kanairiktok River, marine molluscs (*Clinocardium ciliatum*) were found at 54° 50.27'N 60°41.82'W at 80 m asl. A date on *Portlandia* shells of 7950 ± 95 years BP (Beta-28885) was reported by Awadallah and Batterson (1990) from a nearby site on the Kanairiktok River. All these species are indicative of shallow, cold water conditions (Lubinsky, 1980). The shell sample from the Adlatok River site has been submitted for radiocarbon dating.

Proximal marine sediments were well sorted, fine to medium sands. These sediments commonly overlie distal marine muds. Some sections exposed dipping beds of sand and gravel, consistent with deposition in a delta. Deltas are found at several elevations between the marine limit of 125 m

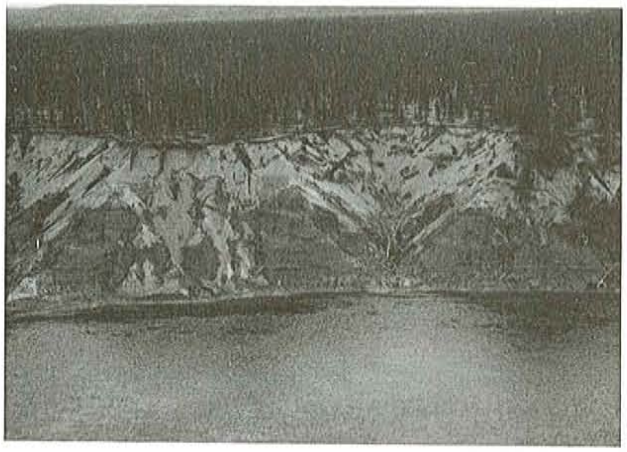


Plate 3. *Fluvial sand overlying marine mud in the Kanairiktok River valley. The mud was deposited offshore during higher relative sea levels early in deglaciation. The mud is found up to about 100 m asl in the Kanairiktok and Adlatok River valleys. The sand was deposited by rivers that developed as sea level fell.*

asl and the modern coast, and represent deposition during the progressive falling of relative sea levels following deglaciation.

The common stratigraphy in areas below marine limit was distal marine muds fining upward to proximal marine, and fluvial sands (Plate 3). This stratigraphy was exposed along river channels. Areas of slope instability were common along the channel sides, and were probably triggered by the saturation of sediment above the impermeable mud layer. An interesting phenomena is the absence of gravel in many of the sections, apart from near the surface. The presence of several large lakes, such as Shapio Lake, adjacent to the main valleys may suggest that the coarse fraction was deposited in the lake basins.

Marine sands and muds may have been derived from local till. However, they were transported through a fluvial system, and further reworked in the marine environment. Furthermore, some material may have been contributed by icebergs from well outside the local area. As such, these sediments are unsuitable for use in any drift-exploration program.

AEOLIAN

The stratigraphically highest unit are fine sands that form parabolic sand dunes (Plate 4). They were found on the east side of sand-filled valleys of the Adlatok and Kanairiktok rivers (Figure 3), commonly draped over and up the side of bedrock hills, or overlying near-shore marine sands. The sand

Plate 4. *Parabolic sand dunes in the Kanairiktok River valley. Similar dunes also occur in the Adlatok River valley. In both areas, they are only found on the highest terrace surfaces, suggesting they formed shortly after the area emerged from falling sea levels.*

dunes are oriented with the apex of the parabola parallel to the prevailing wind at the time of their formation. The dunes are mostly inactive, although unvegetated areas on some surfaces suggest recent minor activity. The dunes were likely formed soon after exposure of adjacent sand plains during falling relative sea levels. The dunes were deposited by a palaeo-wind blowing eastward to northeastward, similar to the prevailing wind today, and were stabilized once vegetation became established.

These features were formed from reworked fluvial sands. They are unsuitable for use in drift-prospecting surveys.

WETLANDS

Areas of wetland (bog and fen) were common across the area, particularly in valleys underlain by marine muds. Organic accumulations were commonly less than 2 to 3 m thick in the lowlands, and less than 1 m over upland areas. These areas are unsuitable for drift-exploration programs.

FLUVIAL

Fluvial sediments consist of moderate to well sorted gravel, sand and silt deposited within or adjacent to modern stream channels. They were found along the Adlatok, Ugjoktok and Kanairiktok rivers, and commonly form bars within the stream channels (Figure 3). Fluvial sands are also found overlying marine muds.

These sediments were deposited in a river system, commonly being reworked from the channel sides. They are a further derivative of primary till, and should be used with caution in drift-exploration programs.

GLACIAL HISTORY

An aerial photograph interpretation of the southern Hopedale block area, and a brief field visit allowed some preliminary observations to be made concerning the glacial history.

The study area was completely covered by ice during the Late Wisconsinan. Ice flow during the Late Wisconsinan, and possibly during earlier glacial periods, was unidirectional toward the northeast (Figure 2). Some local variations in direction were found, especially toward the coast, but in all cases ice flow was parallel to the major bays. In no place was more than one ice-flow direction recorded. The pattern of ice flow was generally coincident with bedrock structure, especially to low-relief bedrock ridges that are common throughout the area.

Based on radiocarbon dating of marine shells and description of marine limit features by Awadallah and Batterson (1990) south of the field area, and by Clark and Fitzhugh (1992), it is likely that the coast became ice free about 8000 years BP. Deglaciation of an isostatically depressed coast led to the development of several deltas that are now located well inland of the modern coast. The highest marine features were deltas in the Adlatok River valley, one at about 50 km inland of the modern coast and at 125 m asl, and another at about 3 km north of Florence Lake at 120 m asl and about 15 km from the present coast. The surface of the high delta in the Adlatok River valley contains large, roughly circular depressions (kettleholes?) and is fed by a valley containing an esker, suggesting it is ice proximal, whereas the delta north of Florence Lake shows no evidence of proximal ice. Both these features are undated. Marine muds found in the valleys below these deltas were found to contain marine shells. The muds were found up to an elevation of about 100 m asl. A similar observation was made by Batterson *et al.* (1988) in the Kanairiktok River valley to the south. The marine muds were commonly covered by up to 15 m of sand (Plate 3). The internal structure of the sands was poorly exposed, but in places showed dipping beds (foresets?), suggesting deltaic deposition. Other exposures showed rippled, well-sorted sands. Rapidly falling relative sea levels (Clark and Fitzhugh, 1992) following deglaciation promoted downcutting of streams, producing a series of well developed terraces that are evident along all the major rivers. At least 6 such terrace levels were found along the Adlatok River. However, the surfaces of the terraces exhibit different characteristics. Along the Adlatok and Kanairiktok rivers, parabolic sand dunes (Plate 4) were found on the upper terraces above about 80 m asl, but not on the lower ones. This suggests that the sand dunes were formed early during exposure of the coast by falling sea levels, possibly about 7000 years BP (cf. Clark and Fitzhugh, 1992). Upper terrace surfaces also commonly showed a braided-stream pattern, whereas lower ones did not (see Batterson and Liverman, 1995). The braided pattern is consistent with high and variable discharge commonly associated with a proglacial fluvial environment (Ashley *et al.*, 1985; Walker, 1984) that produces a network of shifting bars and channels. As glacial influence diminished, stream channels become more stable and less braided, as seen on the lower terrace surfaces.

IMPLICATIONS FOR MINERAL EXPLORATION

Much of the area has well-exposed bedrock surfaces, but for those areas that are covered with a mantle of Quaternary sediment the following points should be considered.

1. Ice flow across the area was simple, with a unidirectional trend toward the coast in a 040 to 060° direction. Geochemical or boulder dispersal trains in till should be linear toward the northeast.
2. The highland areas commonly have a thin and discontinuous till cover. This sediment is suitable for conventional drift exploration because it appears to be mainly local in origin, although some erratic clasts are found that originated over 50 km up-ice.
3. Areas where drift exploration is more complex are those with sediments not deposited directly by glaciers, although they are derived from till. These include the well sorted sand, gravel and muds found in the major valleys. Much of the coarser, well sorted material was deposited by glacially fed streams. The transport path of this sediment is commonly unrelated to the ice-flow pattern described above, and the transport distances of sediment is much greater than till. However, mineralized clasts can be traced up stream, to where they are being eroded from the till, beyond which conventional drift-exploration techniques can be employed. Glaciofluvial sediments, including eskers, have been used in mineral exploration, especially for diamonds (Lee, 1968; Ryan and McConnell, 1995), although the natural sorting also makes these sediments a suitable medium for heavy mineral concentrate analysis. The combination of data from glaciofluvial and till-geochemistry surveys should always be avoided.
4. Marine limit in the study area is about 125 m asl. It is defined by several deltas, commonly with abandoned beaches on the frontal apron. This means that in general, areas below about 125 m were covered by higher sea levels immediately following

deglaciation. Some areas may however have remained ice covered and were not invaded by the sea. Florence Lake for instance, lies at an elevation below marine limit, although no marine sediments were found in it. The lake also contains an esker that may not have survived prolonged inundation by the sea. This valley may therefore have contained glacier ice during the period of higher sea levels, and became ice free after relative sea level had dropped to below the level of the outlet. In areas that show clear evidence of marine inundation, any mineralized erratics found, or geochemical and geophysical anomalies encountered, may be related to deposition within a marine environment. Sediments encountered in this area are well sorted sands and bedded silts and clays, rarely containing marine shells. Marine sediments are a further derivative of primary till, and are further complicated by the introduction of material from outside the local area by ice bergs. The use of marine sediments in mineral exploration programs should be avoided.

ACKNOWLEDGMENTS

I thank Don James, Randy Miller, John McConnell and their respective crews who made my stay at Florence Lake a pleasant one. Wayne Tuttle and Richard White were prevailed upon for their usual high-quality expediting skills. John Maunder, Natural History Curator for the Newfoundland Museum, identified shell fragments. The manuscript was improved through critical reading by Dave Liverman.

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