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QUATERNARY GEOLOGY OF THE DEER LAKE AND PASADENA MAP AREAS (NTS 12H/3 AND 12H/4)

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ABSTRACT

Field mapping of the character and distribution of Quaternary sediments and erosional features in the Deer Lake–Pasadena map areas has led to the development of a tentative model of glacial, deglacial and postglacial geological events in the area. Also, this data aids mineral exploration by defining suitable sediments for drift prospecting, and also agricultural, water-resource and land-use applications, by identifying the location and extent of surface or subsurface sediments.

Ice-flow directions were determined from erosional features, mostly striae, clast-provenance studies, and clast-fabric analysis. Three flows were identified, all considered to be Late Wisconsinan in age. The earliest ice flow was a topographically controlled event oriented down Deer and Grand lakes (from as yet undefined ice centres). The second, regional-flow event was from the Topsail Hills toward the coast. Some deflection took place around highlands near the coast, and fiords on the coast had a draw-down effect. The last flow was a local, southward flow found in the area to the east of Glide Lake. Clasts from the Topsail Hills are common in diamictons across the entire field area. Clast fabrics from these diamictons suggest deposition by the regional, Topsail Hills-centred flow.

Glaciation has produced a wide range of sediment types. Glacial diamictons are common across the whole area, although in many places they have been modified by colluvial activity. Glaciofluvial sediments are extensive and occupy the Howley lowlands, the Junction Brook valley and the Humber River valley. They have been reworked in some areas by Holocene stream activity. There is evidence for a large proglacial lake that occupied the Deer Lake–Grand Lake–Sandy Lake–Birchy Lake basins that was dammed by ice in the Humber gorge near Corner Brook. When this dam broke, the Deer Lake basin was inundated by the sea up to an elevation of about 50 m asl. Radiocarbon dating of marine shells from the Humber suggest marine inundation occurred before 12,600 years BP.

INTRODUCTION

Landscape development in the Humber River valley of western Newfoundland has been dominated by glacial and postglacial events. The area is situated between two Late Wisconsinan ice centres. One was on the Long Range Mountains and likely affected areas as far east as the Baie Verte Peninsula (Liverman, 1992). The other was on the Topsail Hills and is identified as affecting areas from Corner Brook in the west (Batterson and Vatcher, 1992) to Bonavista Bay in the east (St. Croix and Taylor, 1991). The individual influence of each of these ice masses on the Humber River valley remains uncertain. The legacy of glaciation is seen in the thick glacial sediments found in the area. Glacial diamictons are widespread, but glaciofluvial, glaciolacustrine and postglacial marine and fluvial sediments have also been described (Grant, 1989a; Batterson and Vatcher, 1992). The relative fertility of these waterlain sediments, compared to much of the rest of the Island, have formed the basis for farming and forestry. These sediments have also produced engineering and geotechnical problems, especially where marine silts and clays have been found beneath sands.

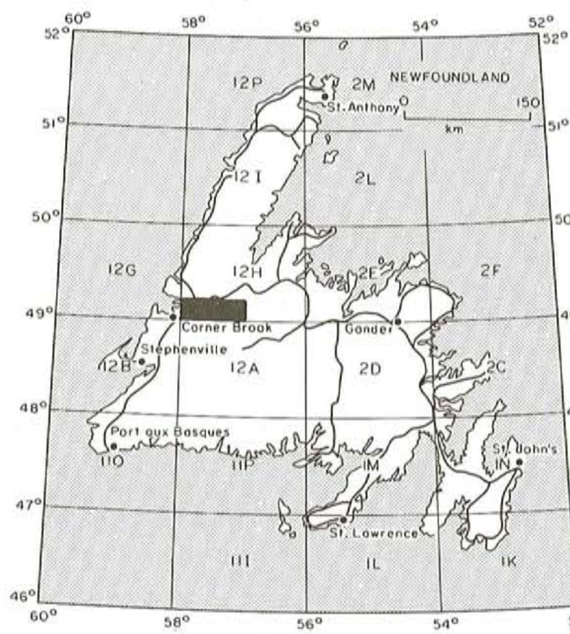


Figure 1. *Location of field area.*

This report describes work carried out in 1992 on the Deer Lake map area (NTS 12H/3) and the northern half of the Pasadena map area (NTS 12H/4) (Figure 1). This work is the second year of a mapping project in the Humber River valley. The objectives of this project are to map the distribution of sediments, to describe their geomorphic characteristics and physical sedimentological properties, and to develop a model for the glacial and postglacial development of the landscape. Also, the data generated by this project should assist mineral exploration, forestry and agriculture, as well aiding road and housing construction, and in water- and waste-management projects.

LOCATION AND ACCESS

The field area roughly spreads from Howley in the east to Goose Arm in the west, and Pasadena in the south to Reidville in the north. Access to the area is generally good, along paved roads or an extensive network of woods roads, particularly in the Goose Arm area and around Glide Lake. Several large lakes, (e.g., Deer Lake and Grand Lake), offer boat access to lake-shore exposures. The highland to the north of Hinds Lake is largely inaccessible, except by helicopter. The major community in the area is the town of Deer Lake at the head of Deer Lake, although smaller settlements occur in the Humber River valley (e.g., Pasadena, Pynn's Brook, St. Judes, Spillway, Reidville, Nicholsville), and in the Grand Lake basin (e.g., Howley).

BEDROCK GEOLOGY

The area contains Cambrian to Carboniferous bedrock (Hyde, 1984; Whalen and Currie, 1988; Williams and Cawood, 1989) (Figure 2), which has influenced the physiography. The Humber River valley is a lowland, less than 140 m above sea level (asl), and is underlain by relatively soft Carboniferous clastic sedimentary rocks. To the east of Grand Lake, rugged hills ranging up to 600 m asl and covered by a thin veneer of overburden are underlain by Silurian felsic volcanic and granitic rocks of the Topsails Intrusive Suite and Springdale Group. To the west of Deer Lake, the highlands rise up to 500 m asl; bedrock, which is covered by a thin cover of Quaternary sediments, consists of Cambrian limestone and dolomites.

Many rock types in the study area have distinctive physical properties and their distribution is important to the reconstruction of paleo-glacier flows. Red sandstone and siltstones are commonly identified with the Carboniferous rocks of the Deer Lake basin. Their widespread distribution throughout the area (from Pasadena in the south, up toward White Bay in the north), constrains their use to the interpretation of regional ice-flow patterns. Dispersal from two major ice centres, which were situated in the region, can be distinguished from data derived from clast lithology of the glacial diamictons. Diamictons derived from the Long Range ice centre (to the north of the field area) should contain Precambrian gneisses, whereas diamictons from the Topsail Hills ice centre should contain rhyolite, one- or two-feldspar granites (some of which are peralkaline), and quartz-feldspar-porphyry clasts.

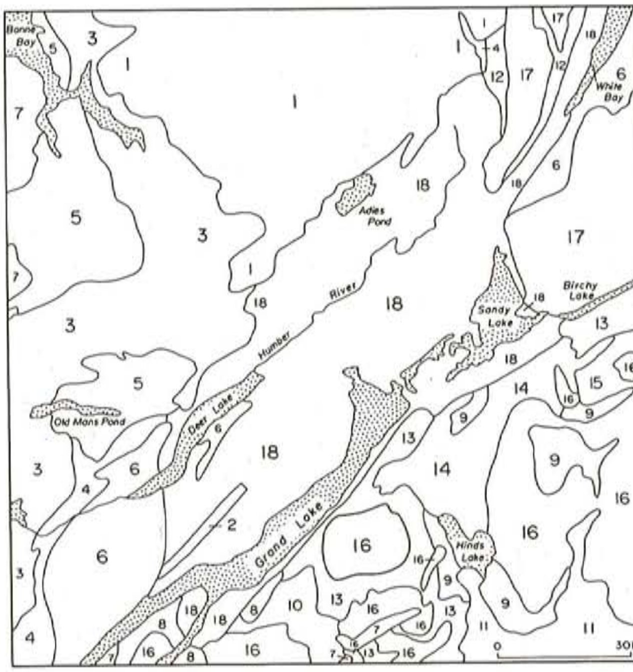


Figure 2. *Simplified bedrock geology map. Modified from Hyde (1984), Whalen and Currie (1988) and Williams and Cawood (1989).*

PREVIOUS WORK

The area has been the subject of 1:250 000-scale surficial mapping (Grant, 1989a), reconnaissance-level 1:50 000-scale surficial mapping (Vanderveer, 1987; Kirby *et al.*, 1988), and is mentioned in overviews on the glacial history of the Island (e.g., Grant, 1989b), and in soil reports on the area (e.g., Kirby *et al.*, 1992). Researchers generally agree that the area was affected by ice from the Long Range Mountains. Vanderveer and Sparkes (1982) report at least two separate ice-flow events originating in the Long Range Mountains on the basis of striae and clast provenance, affecting the Humber River valley as far south as Deer Lake. Rogerson (1979), on the other hand, records northward ice-flow directions up the Humber River valley from a source in the Topsail Hills, as well as ice entering the basin from the Long Range Mountains. Batterson and Taylor (1990), in reviewing the evidence for these flows, speculated that the area was affected by an early flow from the Topsail Hills and a later topographically controlled flow event from the Long Range Mountains. Batterson and Vatcher (1992) refined this pattern and identified an early topographically controlled flow event in the Pasadena area, oriented down Deer Lake. Batterson and Vatcher (1992) also described the Quaternary sediments in the Pasadena and Corner Brook map areas, and reiterated the earlier speculation (e.g., Batterson and Kirby, 1988; and Batterson and Taylor, 1990) that the area had maintained a large proglacial lake during deglaciation and that its drainage had allowed marine inundation of the Deer Lake basin below about 50 m asl.

FIELD AND LABORATORY INVESTIGATIONS

Bedrock outcrops were examined for striae and other ice-

LEGEND (for Figure 2)

CARBONIFEROUS

18 *Carboniferous clastic sedimentary rocks*

SILURIAN

17 Wild Cove Pond and Gull Lake Intrusive Suites: *Biotite granite, granodiorite, diorite*

16 Topsails Intrusive Suite: *Rhyolite, one-feldspar and two-feldspar granites; some have peralkaline affinities*

15 *Quartz syenite, quartz monzonite, diorite, gabbro*

14 Hinds Brook Granite: *Massive to slightly foliated biotite granite to granodiorite*

13 Springdale Group: *Flow-banded rhyolite, tuff, basalt*

12 Sops Arm Group: *Felsic volcanic rocks, volcaniclastic rocks*

11 Buchans Group: *Pillow lava, volcaniclastic and felsic volcanic rocks, shale*

10 Rainy Lake Complex: *Gabbro, diorite, granodiorite*

ORDOVICIAN

9 Hungry Mountain Complex: *Moderately to strongly foliated gabbro to granite*

8 Glover Group: *Basalt, diabase, tuff and conglomerate*

7 *Gabbro, diorite, basalt*

6 Fleur de Lys Supergroup: *Pelite, psammite, schist; includes* Mount Musgrave Group

CAMBRIAN

5 *Grey to black shale and thin white quartzite*

4 *Crystalline limestone and phyllite*

3 *Shale, limestone, dolostone (includes* Reluctant Head Formation)

UPPER PROTEROZOIC TO LOWER CAMBRIAN

2 Hughes Lake Complex: *Metavolcanic rocks and granite*

PRECAMBRIAN

1 *Gneiss, paragneiss*

flow indicators, such as nailheads, crescentic gouges, and stossed surfaces. Fifty-three striation sites were recorded to supplement those identified during previous projects. Detailed descriptions of surficial sediment were made from natural or man-made exposures, including 20 backhoe test-pits. Sedimentological properties examined included texture, compaction, sedimentary structures and clast lithology. Clast fabrics were taken from 65 diamicton exposures. In each case, 25 elongate pebbles, having a length:breadth ratio of greater than 3:2 were measured. Results were plotted on a stereogram and analyzed using the Stereo™ software package for the Apple Macintosh microcomputer (MacEachran, 1990). Principal eigenvalues, which measure the strength of the fabric orientation, and K values, which measure the distribution of the clast orientations (i.e., plunges), were produced using the method outlined by Woodcock (1977). Normalized eigenvalues (Sl) can range between 0.33 (random) and 1.0 (unidirectional). K values of less than 1.0 suggest girdle distributions. In this paper, strong fabrics are defined as those with $S1 > 0.6$ and $K > 1.0$.

Matrix samples were taken from 142 locations for textural and possible geochemical analysis. Grain-size results are not currently available. Clast samples (coarser than 64 mm/-6∅) of between 50 and 100 clasts were taken from 83 locations, and rock types identified.

RESULTS

ICE FLOW

Most striation sites record a single ice-flow direction (Figure 3). Those recording more than one flow are largely restricted to the highlands east of Glide Lake, the Deer Lake

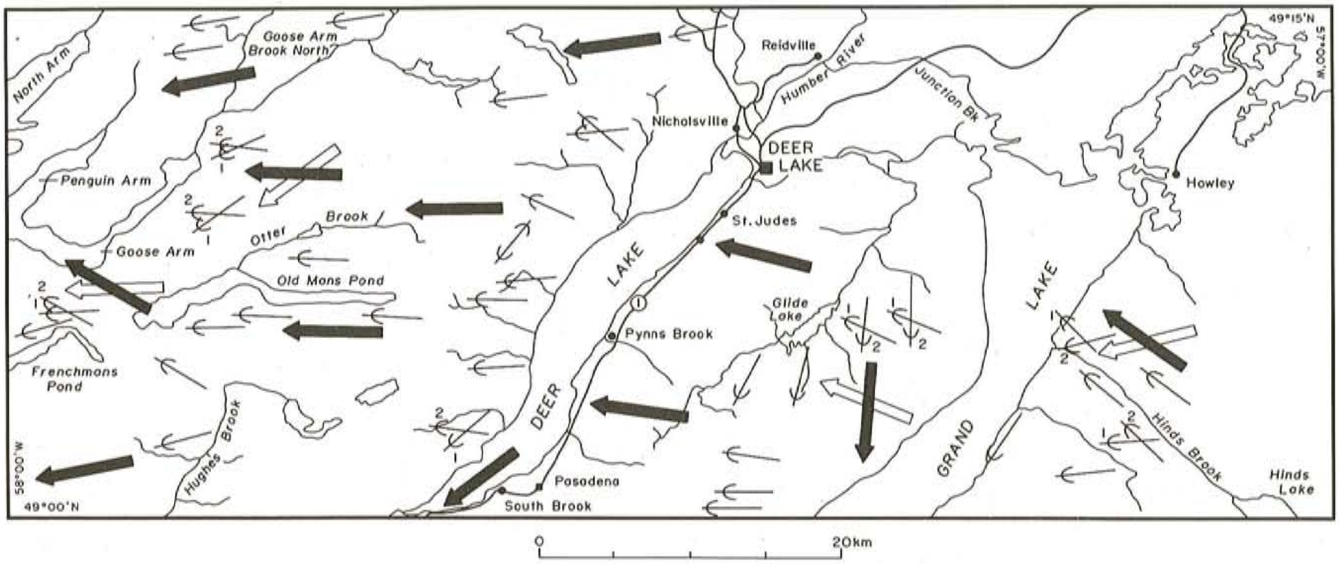


Figure 3. *Ice-flow map. Data from glacial striae; numbers on arrows show age relationships (1 is the oldest).*

basin between Pasadena and Deer lake, and in the Goose Arm area. The striation record shows at least three main flow events affected the area. An early, presumably topographically controlled event is found within and parallel to the Deer Lake and Grand Lake basins, but not on the intervening highlands. This flow was found as far south as the Humber gorge (Batterson and Vatcher, 1992). The second flow was a major westward flow that affected the area from Hinds Lake in the east, to the coast in the west. In the area around North Lake, this flow is oriented slightly north of west, and in the Goose Arm area, it is southwestward. Regional work by Taylor and Vatcher (*this volume*) suggests that these flows are equivalent and relate to deflection of ice around the highlands north of North Arm. Coastal topography, particularly Goose Arm, Penguin Arm, and Frenchmans Pond, also had the effect of locally deflecting ice-flow directions, producing crossing striae on bedrock outcrops. A late-stage southward ice flow is found on the highlands east of Glide Lake. This southward event likely affected the Glide Lake valley but did not extend south of it, where only evidence of westward flowing ice is found. Taylor and Vatcher (*this volume*) also show a late southward ice flow in the northern part of the Humber River valley, but it is difficult to determine if the southward flow in the Glide Lake area can be equated with it.

Directions of glacial transport determined from 19 well-oriented clast fabrics (i.e., $S1 > 0.6$ and $K > 1.0$) from glacial diamictons across the field area generally correspond to the regional, westward phase of ice movement. The relationship of clast fabric to ice-flow directions has been amply demonstrated (e.g., Harrison, 1957; Lawson, 1981; Dowdeswell and Sharp, 1986).

CLAST PROVENANCE

The inclusion of clasts of distinctive character and discrete geographic origin found within sediments identified as glacial diamictons (tills) provide sound evidence for glacial transport directions and distances (Plate 1). In general, tills

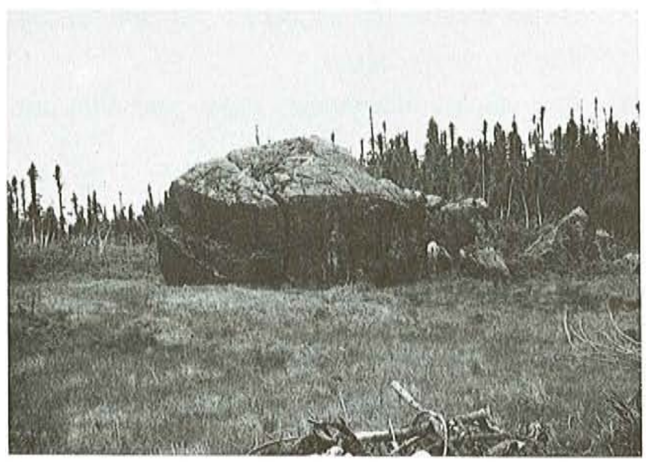


Plate 1. *Large rhyolite erratic in the Hinds Lake area. The bedrock source for this boulder is less than 1 km to the east.*

within the area are strongly influenced by the underlying bedrock geology, with the composition of exotic clasts generally being less than 10 percent. Striae and fabrics suggest southward and westward ice flow. A southward flow originating, as earlier workers have suggested, in the Long Range Mountains should contain a component of Precambrian gneiss and granitic gneiss. A westward flow may contain felsic volcanic and granitic (some peralkaline) clasts from the Topsail Hills. Rock types identified from tills in the field area show that the ice crossed the Topsail Hills. In particular, flow-banded rhyolites originating from the Springdale Group, pink, medium- to coarse-grained K-feldspar porphyritic two-feldspar-granite from the Hinds Brook granite, and a red, medium- to coarse-grained one-feldspar-granite from the Topsails intrusive suite were used to confirm ice-flow directions. These were found in highland areas to the west of Deer Lake and on the highlands to the west of Glide Lake, which are removed from any potential influence of fluvial transport and subsequent reworking by glacial activity. Clasts originating from the Buchans Group farther east were not identified in the field area, suggesting that the ice-dispersal centre lay to the west of Red Indian Lake.

QUATERNARY SEDIMENTS AND FEATURES

Glaciation has produced a wide range of sediment types across the study area (Figure 4). These include diamictons, glaciofluvial and fluvial, glaciolacustrine, glaciomarine and marine sediments. A brief description of these sediments follows.

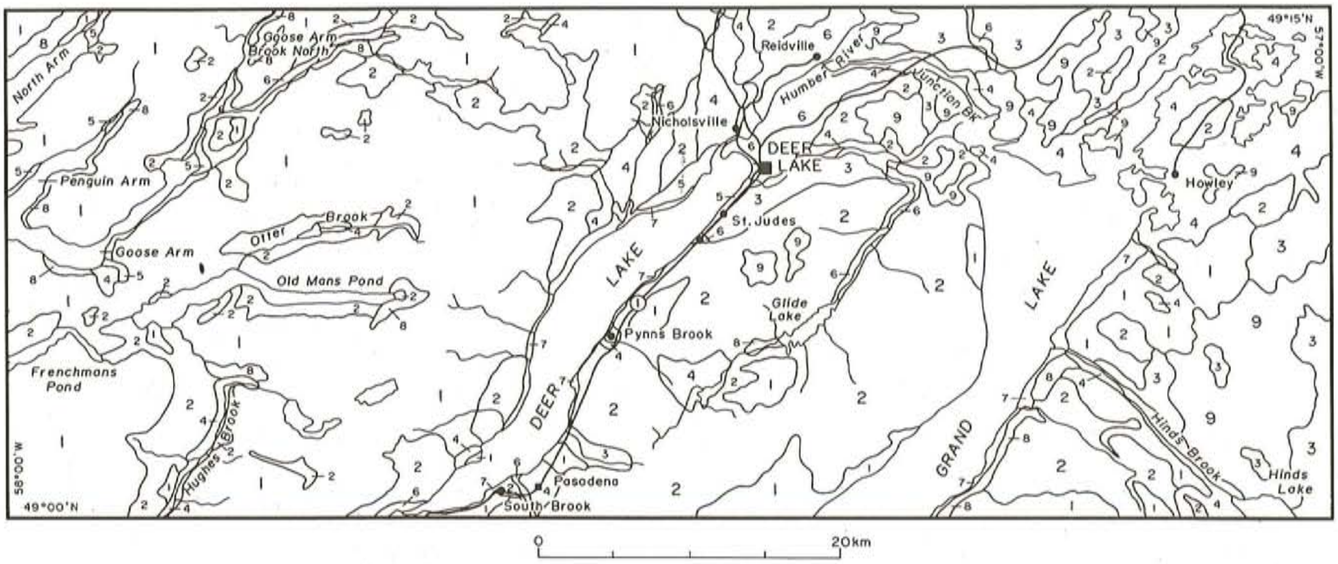
Diamictons

Diamictons are common throughout the map area (Figure 4). They vary in thickness from less than 1 m over the limestone-dominated highlands to the west of Deer Lake and over the granitic terrain of the Topsail Hills, to over 3 m in the Deer Lake lowlands and as isolated pockets across the remainder of the area. Till characteristics are commonly related to the underlying bedrock geology and the directions of glacial transport.

In the Hinds Lake area, diamictons commonly have a Munsell colour of very dark to dark greyish brown (10YR 3/2 to 10YR 4/2) when moist, and light grey to light brownish grey (10YR 7/2 to 10YR 6/2) when dry. They generally have a fine sand matrix and numerous irregular shaped, subhorizontal, massive, medium- to fine-sand lenses. A thin (1 mm), medium- to fine-sand lamina is common beneath clasts. Most clasts are granites of local origin, and some are striated. Clast fabrics commonly have strong S1 values (i.e., greater than 0.6) but low K values (i.e., less than 1). Where strong fabrics are found that may relate to glacier-flow directions, they record southwestward ice movement (azimuth 310°). Commonly, only one diamicton is found in natural or man-made exposures, although near Hinds Lake dam, a section exposing 3 diamictons is found. The lower diamicton is dark greyish brown (10YR 4/2) when moist, and grey (10YR 6/1) when dry and has a very fine sand to silt matrix; this diamicton is matrix-rich (80 percent matrix), has a well-developed subhorizontal fissility and is moderately consolidated. Clasts are up to cobble size and of local derivation. Clast fabric shows a strong S1 value (0.79) but a low K value (0.75). Along an undulating, gradational contact of this diamicton with the overlying sediment, a stone-line, comprising subrounded, flat-lying cobbles, is found. A 1- to 1.25-m-thick, sandy diamicton overlies this contact. It is dark brown (7.5YR 4/2) when moist, and pinkish grey (7.5YR 6/2) when dry and has a fine sand matrix along with numerous lenses throughout. Clasts within this sandy diamicton are up to 30 cm in diameter and mostly of local origin, although more exotic clasts are found than in the underlying lower diamicton. Clast fabric has a moderate S1 value (0.60) and low K value (0.37). This sandy diamicton contains several stone-lines, all 1 to 2 clasts thick. Overlying the topmost stone-line is another (75-cm-thick) sandy diamicton. It is dark greyish brown (10YR 4/2) when moist, and light greyish brown (10YR 6/2) when dry, and has similar characteristics to that just described, except that clasts are commonly less than 5 cm diameter, and it has a weaker fabric (S1=0.58, K=0.26). The diamictons become more consolidated and finer textured with depth. The lower diamicton is interpreted as a basal till, possibly a lodgement till. The strong, unimodal fabric, the absence of sorting, the local, striated clasts are consistent with this argument (Dreimanis, 1988). The overlying middle sandy diamicton is interpreted as a subglacial meltout till. It has a strong, unimodal fabric with a girdle distribution, which Lawson (1981) suggests may be the result of resedimentation during the melt-out process. The unit has sorted lenses throughout, and stone-lines (Plate 2), which suggest the presence of flowing water during deposition, and the unit contains clasts of slightly more distal origin than the underlying till. All these characteristics are consistent with a subglacial melt-out till origin (Haldorsen and Shaw, 1982; Shaw, 1982; Dreimanis, 1988). The upper sandy diamicton has similar characteristics to the middle sandy diamicton and is also interpreted as a subglacial melt-out till. Glacial diamictons of the types described above are found across the field area, and although individual characteristics may vary, they are commonly interpreted as basal tills.

In the highlands to the east of Glide Lake, diamictons are commonly less than 3 m thick. They are dark brown to very dark greyish brown (10YR 3/3 to 10YR 3/2) when moist, and pale brown to light brownish grey (10YR 6/3 to 10YR 6/2) when dry and have a fine sand matrix with less than 15 percent fines. The diamictons are generally structureless, although some fine sand sorting is common beneath clasts. Clasts are up to boulder size, and dominated by local rock types, although clasts originating in the Topsail Hills are common. Clast fabrics show strong S1 values (greater than 0.6) but low K values (less than 1.0). Where high K values are found, indicating glacial transport directions, interpreted ice flow is slightly north of west (azimuth 290°). Only one diamicton unit is commonly found in this area.

To the west of Glide Lake and through the Humber River valley, diamictons are reddish brown to dark reddish brown (5YR 4/3 to 5YR 3/3) when moist, and light reddish brown (5YR 6/3) when dry and have a fine sand to silt matrix, in which the silt–clay content ranges between 15 to 20 percent. The sand fraction is commonly micaceous. Diamictons are generally massive, although subhorizontal fissility and fine sand sorting beneath clasts are also found. Clasts are dominantly local, particularly red Carboniferous sandstone, although clasts identified as originating from the Topsails Hills were found. Clast fabrics are commonly weak, but where high enough to indicate earlier ice flows and suggested northwestward movement (azimuth 320°). The only exception to these features is an overconsolidated diamicton found in Rocky Brook where it is crossed by the road to Reidville (Plate 3). This diamicton is dark reddish brown (2.5YR 3/4) when moist, and reddish brown (2.5YR 5/4) when dry and has a fine sand to silt matrix. The unit has well-developed vertical fissility oriented parallel to the river bank. Clasts are dominated by local sandstone, although clasts identified as originating from the Topsail Hills were found. Gneiss clasts



LEGEND

POSTGLACIAL

9 Organics: *Accumulations of organic matter deposited in poorly drained areas; commonly underlain by diamicton or bedrock*

8 Colluvium: *Material derived from adjacent slopes and deposited by the force of gravity*

7 Lacustrine: *Sediment 1 to 10 m thick composed of bedded sands and gravels; includes beach ridges and terraces; common along shores of Deer Lake, where they overly marine sediments*

6 Fluvial: *Sediment 1 to 10 m thick composed of planar- and crossbedded, moderately to well-sorted sands and gravels; especially common in Humber River and Hughes Brook valleys*

5 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*

GLACIAL

4 Glaciofluvial deposits: *Sediment 1 to 30 m thick composed of poorly to well-sorted sands and gravels*

3 Till: (> *2 m thick). Sediment generally subglacial till of local provenance; may include relief features such as moraines*

2 Till veneer: (< *2m thick). Sediment generally subglacial till of local provenance; numerous bedrock exposures throughout unit*

PREGLACIAL

1 Bedrock: *Includes exposed bedrock and bedrock with a thin (<1m) vegetation or sediment cover*

Figure 4. *Simplified surficial geology map of the study area.*

of presently unknown provenance were also found in the sediment. Clast fabrics are variable having strong S1 values (0.70 and 0.72) and variable K values (0.60 and 1.18), and showed westward ice flow (azimuth 255°). This till has been described by Vanderveer and Sparkes (1982) who suggested it was a pre-Late Wisconsinan till from a source to the northeast of the Humber River valley, although the clast fabric and Topsail Hills clasts are incompatible with this origin, and are more consistent with a flow from the Topsail Hills.

Diamictons over the highlands underlain by limestone to the west of the Deer Lake basin are commonly less than 2 m thick. They have variable colours, those containing common Carboniferous sandstone clasts are reddish brown (5YR 4/3) when moist, and light reddish brown (7.5YR 6/4) when dry. Diamictons of more local derivation are commonly dark greyish brown (2.5Y 4/2) when moist, and light brownish grey (2.5Y 6/2) when dry. The colour of the diamictons may indicate transport across the Deer Lake basin.

Plate 2. *Stone-line separating a lower possible lodgement till from an overlying subglacial meltout till in a section near Hinds Lake.*

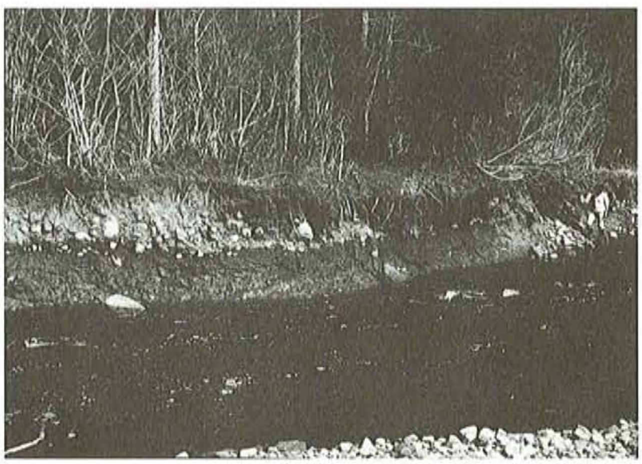


Plate 3. *Overconsolidated subglacial till exposed in Rocky Brook near Reidville. The age of this till is uncertain, although Vanderveer and Sparkes (1982) suggest that it predates the last glacial period.*

Diamictons have a fine sand to fine sand and silt matrix, are commonly structureless, have clasts of variable but eastward provenance and have clast fabrics with strong S1 values and variable K values. Those with strong fabrics are generally consistent with the regional, westward phase of ice movement.

Sixty-five clast fabrics were completed on glacial diamictons across the field area. Clast fabrics were variable, commonly with strong S1 values (> 0.6) but low K values (<1.0) (Figure 5). Data plotting in the upper left side of the graph are unimodal oriented fabrics with high K values, whereas those plotting on the lower right side are fabrics with a girdle distribution. The graph shows 21 of 65 fabrics plot in fields described by Mark (1974) and Woodcock (1977) as representing undisturbed basal tills, and 17 of 65 fabrics plot in fields described as representing disturbed basal tills and debris flows. However, these fields only provide potential depositional environments for diamictons and should not be

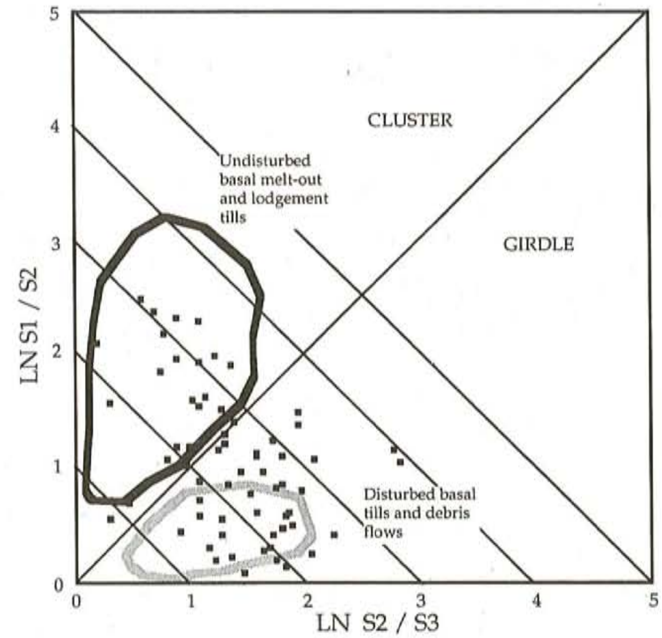


Figure 5. *Graph of fabric data following the method of Mark (1974), Woodcock (1977) and Rappol (1985). The graph may be used to suggest potential depositional environments for glacial diamictons in the area.*

used as diagnostic indicators. The physical characteristics of most of the diamictons found in the field area were discussed earlier and are consistent with a subglacial origin, either as lodgement or as melt-out tills.

Glaciofluvial and Fluvial Sediments

These sediments are widespread in valleys across the area (Figure 4). In particular, the Sandy Lake–Grand Lake lowlands, the Junction Brook valley and the Humber River valley around Deer Lake contain thick glaciofluvial deposits. Other, smaller areas of glaciofluvial sediments are found in isolated localities across the area. Glaciofluvial sediments are formed as a result of drainage from melting ice during deglaciation. In the field area, they are commonly poorly to well-sorted outwash gravels, contain subrounded to rounded clasts up to boulder size, with a fine- to medium-sand matrix. The sediment commonly contain steeply dipping (45 to 60°) crossbedded medium- to coarse-sands and gravels, and numerous randomly distributed, moderately sorted, fine- to coarse-sand lenses. The lenses are irregular shaped and commonly fine upwards. Subrounded Topsail Hills granite boulders are common on or near the surface of the glaciofluvial sediments. In the Howley area, the surface is hummocky, which may be the result of erosion by meltwater activity.

Postglacial fluvial sediments, mostly sands, are common adjacent to the modern Humber River valley. They contain well-defined crossbeds and asymmetric ripples with 1 cm amplitudes and 3 cm wavelengths, suggesting earlier flow parallel with the modern Humber River. They commonly overlie silt and clay sediments that are described below.

Glaciolacustrine Sediments and Landforms

Additional data to support the concept of a large proglacial lake proposed by Batterson and Taylor (1990) is found along the east shore of Grand Lake, where features interpreted as deltas or fan-deltas have been identified (Figure 4). They occur as a series of flat-topped to westward-sloping ridges up to elevations of about 150 m asl, extending at least 15 km south of Howley (Plate 4). Sections show interbedded fine and medium sand to interbedded sandy gravel and gravely sand. The interbedded sands are well sorted, planar bedded, with beds extending laterally in excess of 5 m. Pebbles are rare and do not deform surrounding beds. Beds dip toward the lake at 10 to 15°. The interbedded gravely sands and sandy gravels have 10 to 50 percent of moderately sorted sand matrix. Clasts are commonly subrounded of local rock types, and are less than 5 cm diameter. Beds dip toward the modern lake at 20 to 25°. The geomorphology of these features and their internal sediment composition are consistent with a deltaic origin and are interpreted as being formed during a higher level of Grand Lake.

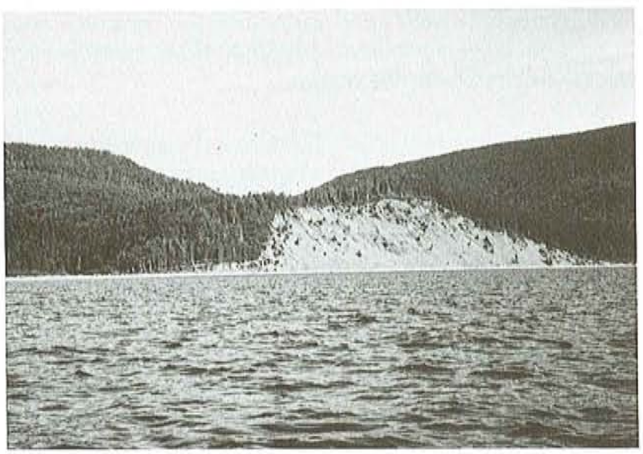


Plate 4. *Possible fan delta along the east shore of Grand Lake near Howley. The surface of the feature is about 140 m asl, and may have formed during a higher stand of Grand Lake.*

Glaciomarine/Marine Sediments and Landforms

Throughout the Humber River valley at elevations below about 50 m asl reddish brown (5YR 5/3, moist), rhythmically bedded silts and clays are found (Figure 4). In the Humber gorge, these sediments are fossiliferous (Batterson and Vatcher, 1992), and have been dated at 12,630 ± 90 years BP (TO-2885). Silt and clay sediments in the Humber River valley are interpreted as marine sedimentation as a result of marine inundation on an isostatically depressed land surface. Features interpreted as deltas based on their surface morphology and internal structure at Pasadena, Pynn's Brook (Batterson and Vatcher, 1992), and at Hughes Brook (Plate 5) and Nicholsville are related to fluvial inflow into the raised sea level.

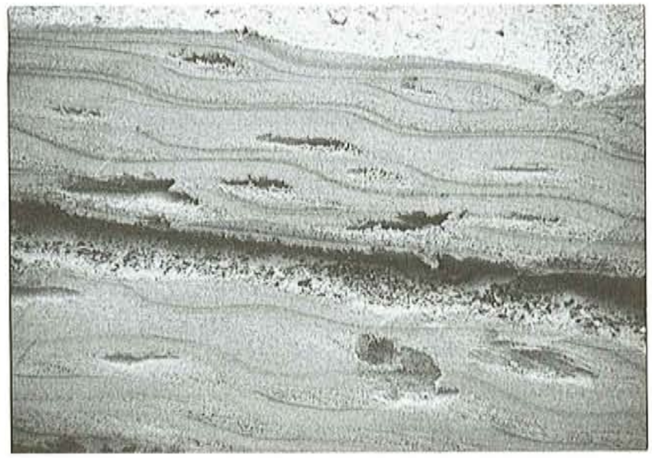


Plate 5. *Draped laminations exposed in a section through a delta in Hughes Brook. The surface of the delta is 58 m asl. Width of plate is 1 m.*

In the Goose Arm area, marine inundation also occurred up to an elevation of at least 50 m asl. In the Goose Arm Brook North valley, about 5 km from the present coast, marine shells (*Mya truncata*) have been found within reddish brown (5YR 4/3) marine clays. The shells have been sent for radiocarbon age determination. Other shell sites were also found in the Goose Arm area, and are also in the process of being dated.

QUATERNARY HISTORY OF THE DEER LAKE–PASADENA AREA

The distribution and characteristics of Quaternary sediments and the orientation of glacial erosional features provide the basis for a preliminary Quaternary history for this area of Newfoundland. Ice-flow data suggests an early topographically controlled ice flow down the Deer Lake and Grand Lake valleys, from unknown ice-dispersal centres. The relative freshness of striae suggests this flow was Late Wisconsinan in age. Following the Late Wisconsinan maximum, ice dispersal was from the Topsail Hills. Ice flow was coastward, with major routes likely being through Old Man's Pond, Goose Arm, North Arm and Frenchmans Pond. The ice was likely thin because flow is deflected around the highlands north of North Arm (Taylor and Vatcher, *this volume*). Late-stage topographically controlled ice flow likely affected the Humber River valley from a source in the southern Long Range Mountains (Taylor and Vatcher, *this volume*). Local ice is also likely responsible for southward-directed striae on the highlands to the east of Glide Lake. Melting of the ice produced large volumes of glacial meltwater and associated glaciofluvial sediments. These are commonly found in the Hinds Brook valley. Another deglaciation effect was the creation of a large proglacial lake covering the lowlands between Corner Brook and the Indian Brook valley. The lake formed as a result of an ice dam in the lower Humber River, probably in the Humber gorge area. The shell date from the Humber gorge site suggests the lake was in existence prior to 12,600 years BP. After the ice dam broke, marine inundation affected the Deer Lake basin up to modern elevations of about 50 m asl, depositing silt and clay sediment. These have subsequently been overlain by postglacial fluvial sediments.

IMPLICATIONS FOR DEVELOPMENT AND LAND-USE PLANNING

The distribution and characteristics of Quaternary sediments affect land-use activities. Mineral exploration is helped by defining those sediments that are suitable for drift prospecting (i.e., glacial diamictons), in contrast to those that are not (e.g., glaciofluvial, fluvial and glaciomarine sediment). Within the Humber River valley and below about 50 m asl, a stratigraphy of marine silt and clay overlain by postglacial sands occurs; the silt and clay are generally impermeable. Surface waters percolate through the more permeable sands to the contact with the silt and clay and then follow this surface down the regional slope. This has important effects on groundwater behaviour. It may result in water supplies from shallow wells, but may also result in the rapid movement of pollutants into the groundwater system from poorly sited land-fill sites and incinerators. These effects are clearly seen around the land-fill sites in the Wild Cove valley near Corner Brook, where local pollution of streams has occurred. The site is underlain by marine clays, on which no postglacial sand was deposited. The movement of pollutants into local streams has therefore been rapid, as has the advent of adverse effects on stream biology. Remedial measures are ongoing in this area.

The poor drainage of marine muds also has an effect on agricultural practices, in that saturation of soils is common where the silt and clay layer occurs near the surface. In these situations, construction of drainage ditches is required to alleviate the problem. Road and bridge construction is also potentially affected by thick mud layers, both from the difficulty of establishing sound foundations for bridges and the possibility of post-construction damage due to the physical instability of the muds. The same problems occur in urban development in areas where thick marine mud sediments are known to occur.

Over much of the field area, the surficial sediment is thin. In areas of logging, increased levels of runoff, higher stream discharges, and increased sediment loads due to increased erosion of unprotected slopes are likely consequences that will require monitoring.

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