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QUATERNARY GEOLOGY OF THE CARMANVILLE MAP AREA (NTS 2E/8)

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ABSTRACT

Surficial mapping of the Carmanville map area (NTS 2E/8) has been undertaken. Ice-flow indicators such as striations, clast fabrics, roches moutonées, crag-and-tails, and lineated till have been measured to determine the ice-flow history of the area. The orientation of striations indicate that the area was affected by three main ice flows. The first was eastward, the second northeastward, and the third was a northwest ice flow. Geomorphic features strongly reflect the northeasterly event and clast fabrics strongly reflect the northwesterly event.

A postglacial marine limit of 67 m above sea level (asl) has been established. This indicates that approximately two thirds of the map area were under water at one time following deglaciation. Other major sea-level stands occur at 52, 38, 34, 17, 11, 5, and 2 m asl. The lower terraces are associated with thick marine gravels.

Six major sediment types have been located and described in the map area. These are glacigenic sediments, organic sediment, glaciofluvial sands and gravels, marine gravels, colluvium, and fluvial sediment. A seventh category is bedrock.

INTRODUCTION

Fieldwork and geological sampling were undertaken in the Carmanville map area (NTS 2E/8) between June and August, 1992. Airphoto interpretation was undertaken prior to the field season and laboratory analysis is currently in progress. Quaternary landforms and deposits have been mapped at a scale of 1:50 000. The objectives of this research are to ascertain ice-flow patterns in the area, to describe the glacial history, and to determine the sea-level history.

Determination of the directions of ice flow will aid in the analysis of the provenance of mineralized clasts and geochemical anomalies within glacial sediment. Differentiation between primary and secondarily reworked glacial debris is crucial to successful mineral exploration. The assessment of sea-level history will aid in evaluating the potential for offshore and onshore marine-placer development. In addition, determination of the nature and spatial distribution of Quaternary sediments and landforms aids in regional planning, recognition of potential environmental hazards, and assessment for aggregate exploitation, waste disposal, and construction purposes.

LOCATION AND ACCESS

The study area is located in northeast Newfoundland between 49°15'N and 49°30'N latitude, and 54°00'W and 54°30'W longitude (Figure 1). It lies approximately 50 km north of Gander, includes Gander Bay in the western part, and extends eastward to the Musgrave Harbour area.

Access within the area is generally very good. Route 330 (Gander to Wesleyville) crosses the map area from southwest to northeast. Other main routes include Route 331 (Clarke's Head to Twillingate) and Route 332 (Fredrickton to Carmanville). Logging roads are common throughout the area, and are generally well maintained.

PHYSIOGRAPHY

The map area is characterized by low relief, with maximum elevations reaching 120 m asl. This gently undulating topography is also reflected offshore, where Gander Bay rarely exceeds 5 m in depth and Hamilton Sound reaches maximum depth of 20 m (Shaw *et al.*, 1990). The long, low-lying elongate ridges, which cross the map area with southwest–northeast trends, reflect the underlying bedrock geology.

Approximately 35 percent of the map area is open-ocean. Coastal processes therefore play a major role in the area. Most of the coastline is bedrock controlled. In areas that face the wave directions (i.e., northeast facing) the coastline is sediment dominated and beach formation is dominant. These

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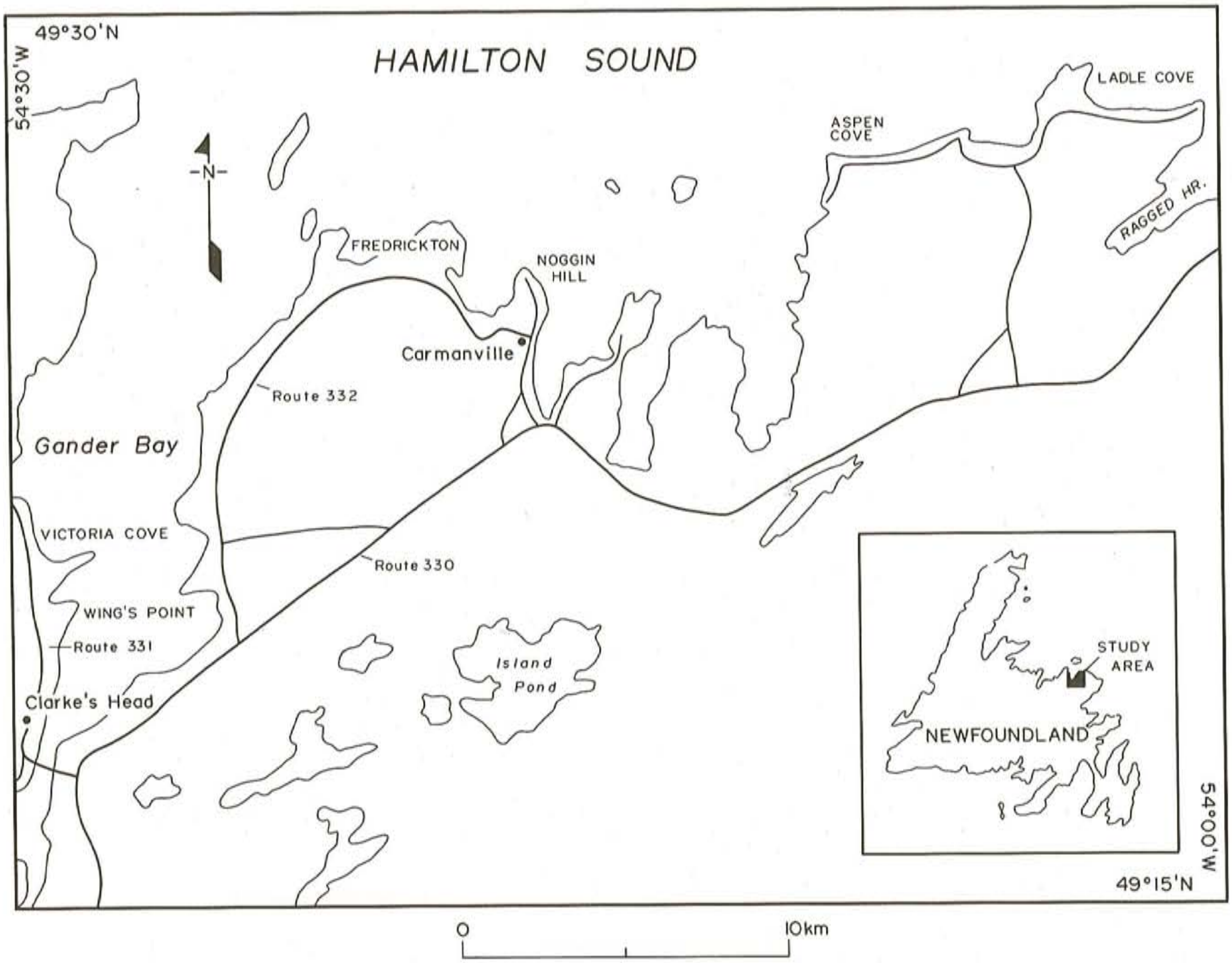


Figure 1. *Location map of the Carmanville (NTS 2E/8) map area and places commonly mentioned in text.*

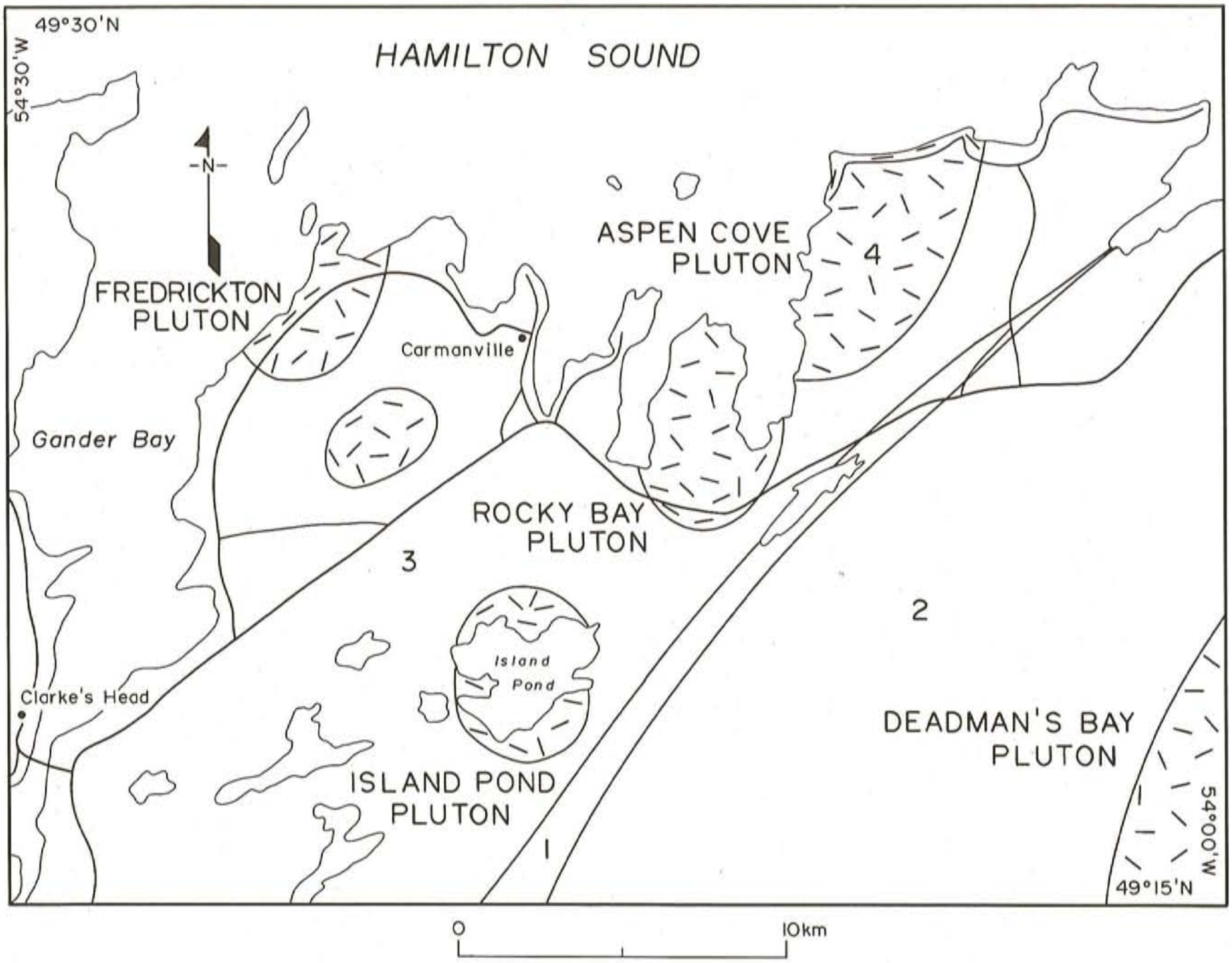
areas include parts of Ladle Cove, the eastern side of Noggin Hill, and the western side of Gander Bay. Areas that face away from the local wave direction (i.e., northwest facing) are much more rugged and have low-lying cliffs. These are especially evident in areas such as the western area of Ladle Cove and the west of Noggin Hill. Approximately 15 percent of the surface area is covered by ponds and 15 percent by bog.

BEDROCK GEOLOGY

The bedrock geology of the study area was mapped by Currie *et al.* (1980). It is dominated by four main geological groups (Figure 2). The oldest rocks in the area are those of the 'Gander River Ultrabasic Belt' (GRUB), which trends southwest–northeast across the area, extending to Ragged Harbour. Major rock types include pyroxenite, peridotite, serpentinite, tuff, agglomerate, pillow basalts, and trondhjemite. To the west of the GRUB, lies the Davidsville Group, which has green siltstones, shales and slates dominating. To the east of the GRUB, lies the Gander Group, composed of green siltstone, garnetiferous gneiss and schist, granitoid gneiss, and granite. The area has several large plutons. The Fredrickton, Rocky Bay, Tim's Harbour, Aspen Cove, and Island Pond plutons are coarse-grained white granites, which intrude the Davidsville Group. The Deadmans Bay Pluton is a buff megacrystic, biotite-rich granite, intrusive into the Gander Group.

Clasts from these rocks are commonly incorporated in glacigenic sediments, and serve as indicators of provenance, transport direction, and distance of transport. Of particular importance are clasts from the GRUB, and clasts from the western metamorphosed area. Even minor occurrences of ultramafic clasts in glacial sediments in the area west of the GRUB would indicate northwestward-moving ice. Sandstone and siltstone clasts in glacial sediments east of the GRUB would represent eastward flowing ice.

Copper, asbestos, and nickel showings in the map area are associated with the GRUB and the Davidsville Group (Andrews, 1980). Glacial sediment derived from the GRUB to the southeast could thus be enriched in chalcopyrite,



1. Gander River Ultrabasic Belt (GRUB)
2. Gander Group
3. Davidsville Group
4. Granitoid plutons

Figure 2. *Generalized bedrock geology of the Carmanville (NTS 2E/8) map area (after Currie* et al., *1980).*

pyrrhotite, and bornite. In addition, other more durable minerals associated with the GRUB (such as orthopyroxenes and olivine) and the Gander Zone rocks to the east (garnet and other metamorphic minerals) would be concentrated in the sediment transported to the east. Although no gold showings, either *in situ* or placer, have been detected in the map area, several occurrences south, southwest, and west of the NTS 2E/8 map area (NTS 2E/1, 2E/2,and 2E/7 respectively) have been identified (Tuach, 1992). These occurrences are also associated with the GRUB and Davidsville Group. As these formations cover more than half the map area, high gold geochemical signatures in glacial materials are possible. Gold-bearing areas contain trace amounts of arsenopyrite and stibnite, so arsenic and antimony may serve to indicate the presence of gold showings in the glacial provenance areas.

Aggregate resources have previously been evaluated in the area (Kirby and Ricketts, 1983). Principal sources of aggregate include Wing's Point, Victoria Cove, and Route 330 between the Aspen Cove turnoff and Musgrave Harbour.

PREVIOUS WORK

The surficial geology of the NTS 2E/8 map area was mapped by Vanderveer in 1977 (Kirby *et al.*, 1988), who reported that hummocky terrain dominates the area with thin eroded till veneers overlying bedrock. Drumlinoid forms and moulded bedrock features, such as roches moutonées and crag-and-tails, are also shown and reflect a northeastward ice-flow event. Striations were mapped and interpreted as being formed by a northeastward ice-flow event. This striation data is supplemented by additional work undertaken in north central Newfoundland (St. Croix and Taylor, 1990). St. Croix and Taylor (*op. cit.*) developed a model, which postulated three ice-flow events in the area, starting from the onset of Late Wisconsinan deglaciation. First, ice from the Northern

Peninsula coalesced with ice from the north Central Uplands resulting in a deflection of the ice masses to the east. This was followed by a northeastward ice-flow event, which originated in the Central Uplands. Finally, there was a northwestward event, which may have originated in the region of the Terra Nova Uplands.

Seismic surveys have been undertaken offshore (Shaw *et al.*, 1990). The substrate is dominantly gravel and bouldery gravel. This is underlain by an acoustic unit with incoherent reflections, interpreted as a glacial diamicton. Drumlin-like forms, also detected at the head of Gander Bay and oriented south-southwest–north-northeast, were interpreted as showing north-northeastward ice flow.

Quinlan and Beaumont (1981) placed the Gander Bay region within either Zone C or Zone D of their sea-level model for the Atlantic Provinces. Zone C is characterized by a sea level, which has fluctuated below present and then gradually risen to its present day level. Zone D is characterized by constantly rising sea levels following deglaciation. Grant (1989), however, suggested a high stand of sea level at 40 m asl for the Gander Bay region and dated this at approximately 12,500 years BP. Shaw and Forbes (1990) incorporated this value into a sea-level curve developed for the Cape Freels area. They suggested that sea level dropped rapidly from between 12,000 and 8,000 years BP, from an elevation of at least 40 m to perhaps as low as -25 m asl. Sea level has been rising slowly since. This sea-level fluctuation represents a Zone B curve using the terminology of Quinlan and Beaumont (1981).

FIELD METHODS

All roads were traversed using automobile, four-wheel-drive truck, or on foot. Orientations of all striations, roches moutonées, crag-and-tails, and lineated till features were measured using a Brunton compass. All natural sections such as river banks and coastal exposures, and artificial exposures such as road cuts and gravel pits were located and described. Sedimentary unit description included unit thickness, colour, matrix texture, sedimentary structures, clast lithology, clast mineralogy, clast shape, and clast fabric. Clast-fabric analysis involved measuring the orientation and dip of the A-axis of 25 clasts in each diamicton unit. The heights of all marine terraces and erosional platforms were measured using an altimeter. The values obtained are assumed to be accurate to 0.5 m.

RESULTS

ICE-FLOW HISTORY

Twenty two single and multiple striation sites were discovered during the field season. (A striation is an erosional scratch or groove on the surface of an ice-abraded rock, produced by the scoring action of rocks frozen onto the base of a glacier). These, combined with information from previously known sites (Taylor *et al.*, 1991), suggest the occurrence of three main ice-flow events (Figure 3). The earliest flow was eastward, followed by an northeastward flow, and finally by a northwestward flow. Commonly, striations from the eastward flow were crosscut by striations from the northeastward flow and both of these were subsequently crosscut by striations from the northwestward ice flow. These observations agree with St. Croix and Taylor's (1990) model for north-central Newfoundland.

Individual exposures show that the eastward flow (where present) is well preserved with striations being on the order of a millimetre or more in depth. The northeasterly flow is also well represented in the striation record and is present at most sites. The northwesterly flow is less well represented with only minor 'scratches' evident (Plate 1).

Geomorphic evidence for ice flow includes roches moutonées, crag-and-tails, drumlins, and flutings. All, except roches moutonées, are restricted to the area south and west of Island Pond. Roches moutonées are present throughout the map area. All of these features have a strong northeast to north-northeast orientation, which is also a reflection of the underlying bedrock. They were therefore formed by the northeastward ice flow. The earlier eastward ice flow is not represented in terms of landforms probably because the ice flow was transverse to the strike of the underlying bedrock. There is no geomorphic evidence for the final flow, and it had little influence on the reshaping of the landscape.

Twenty one clast fabrics were obtained from diamictons and analyzed using the Stereo™ programme designed for the Macintosh computer (MacEachern, 1989). When incorporated into glacial ice, a clast tends to align its A-axis with the direction of ice flow and dips up-ice. Consequently, well-oriented clast fabrics from glacial sediments are good paleo ice-flow indicators (Dowdeswell and Sharp, 1986). Basal tills tend to have unimodal fabrics (Dowdeswell and Sharp, 1986) although basal melt-out tills may be subsequently reworked by water resulting in a more random fabric (Boulton, 1971; Lawson, 1979). Subaerial debris flows can result in less-aligned girdle-distribution fabric alignments (Boulton, 1971) and care must be taken in distinguishing these deposits from primary tills.

The mean orientation of the clasts and the strength of that orientation was established using the method of Woodcock (1977). This involves determining the orientation of a principal eigenvalue (S1). The numerical eigenvalue measures the degree to which the clasts are aligned. The eigenvalue can range from 0.33 (randomly oriented) to 1.0 (perfectly unimodal). These results can be plotted two-dimensionally on a graph (Figure 4). The K-value represents the nature of distribution of a fabric, with values greater than 1 representing cluster distributions and values less than 1 representing girdle distributions. Cluster distributions indicate unimodal fabric alignments, and are generally indicative of undisturbed basal or lodgement tills (Liverman, 1992). Five diamicton fabrics from the area have K-values greater than 1 (Figure 4). They range from 1.22 to 10.69. The principal eigenvalues of these fabrics range from 0.712 to 0.843. These fabrics are therefore unimodal and are interpreted to represent

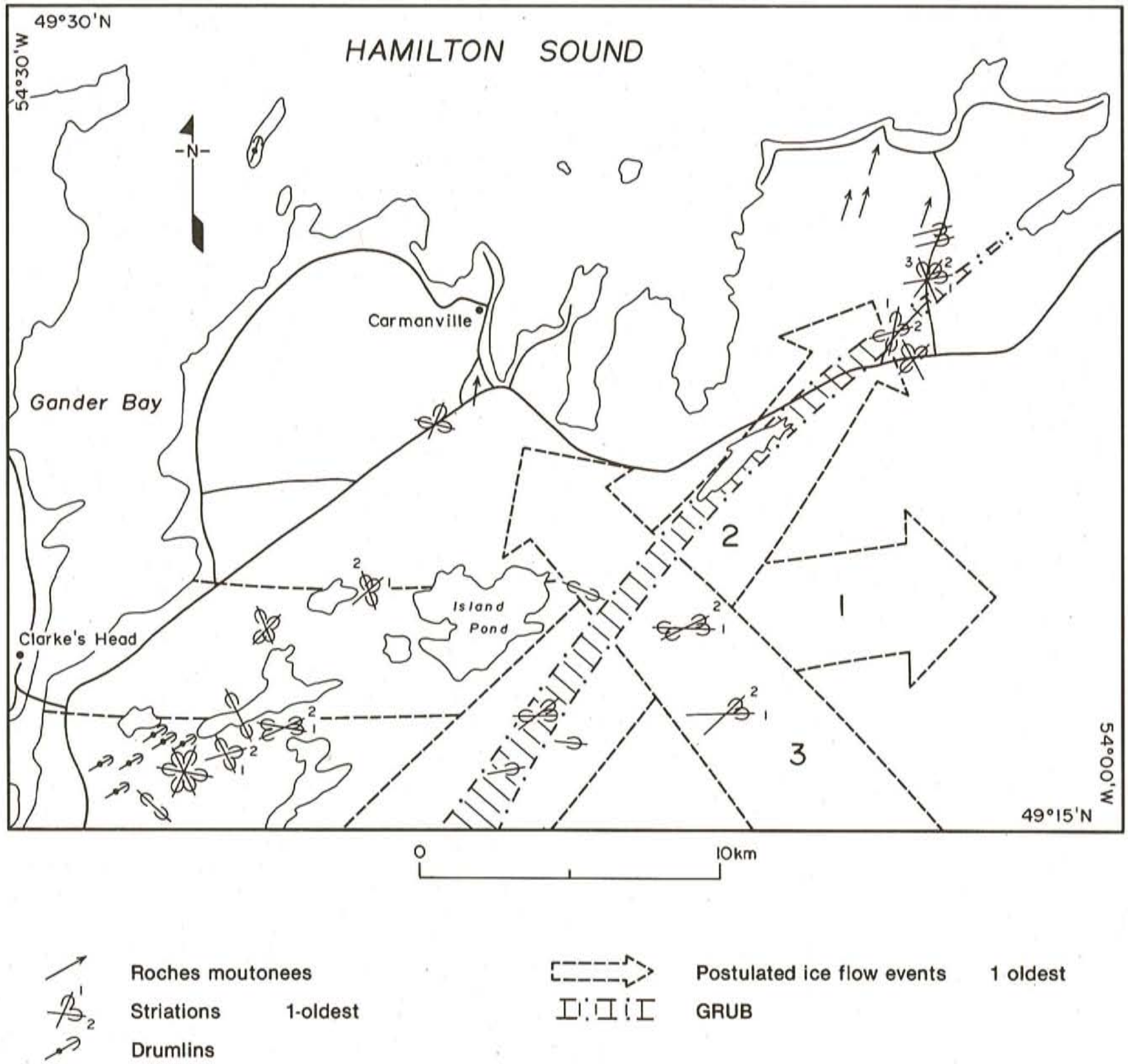


Figure 3. *Map of ice flow-indicators and postulated ice-flow events in the Carmanville (NTS 2E/8) map area.*

the local ice-flow direction. Three of these have northwest orientations, one has a northeast orientation, and one has a easterly orientation. Fabrics, which have been plotted on the girdle part of the graph, have principal eigenvalues ranging from 0.434 (randomly oriented) to 0.814 (unimodal). These probably represent either disturbed basal tills or debris flows. Only one of these deposits was determined to be deposited by easterly moving ice. Three were deposited by northeasterly moving ice, and eight were deposited by northwesterly moving ice. The other deposits were determined to represent debris flows. It would appear, therefore, that although some tills were deposited by the early easterly and northeasterly flows, the majority in the Carmanville area were deposited by the northwesterly moving ice.

SEA-LEVEL HISTORY

Elevations of marine terraces and erosional platforms were measured throughout the field area. These are most prominent at Wing's Point, Noggin Hill, and Aspen Cove. Sea level reached a maximum of 67 m asl, as indicated by erosional platforms measured at Noggin Hill. This is 27 m higher than Grant's (1989) 40 m limit. Sea-level stands of similar elevations have been observed west of the map area where a marine limit of 75 m has been detected at Springdale (Tucker, 1974; Scott *et al.*, 1991). Correlation of the results from Wing's Point, Noggin Hill, and Aspen Cove, show that there were at least seven major still-stands of sea level between the onset of deglaciation and the present day. These are at 52, 38, 34, 17, 11, 5, and 2 m asl.

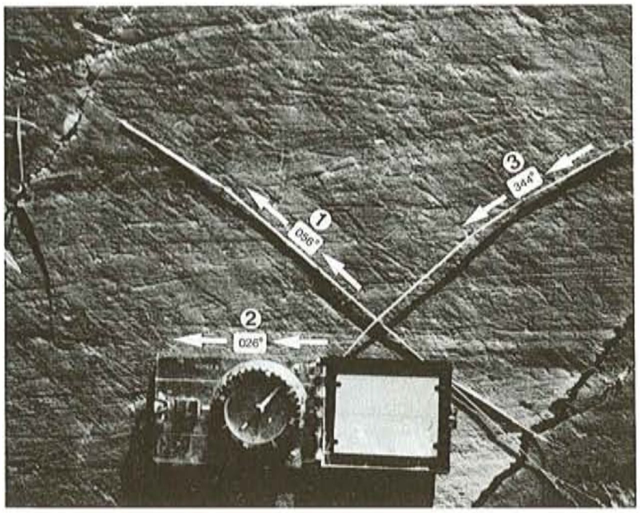


Plate 1. *Striations (from Aspen/Ladle Cove Highway) preserved in the leeside of this outcrop represent the three main ice-flow directions evident in the map area. They represent, (1) an initial easterly flow; (2) a subsequent northeasterly flow and (3) a final northwesterly flow.*

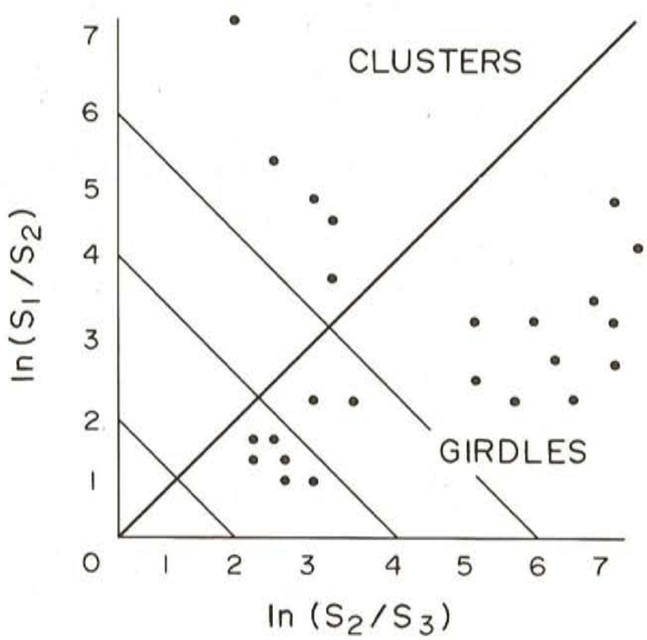


Figure 4. *Diagram of clast fabric eigenvalues using the method of Woodcock (1977). The Y-axis is the logarithm of the ratio between S1 and S2, and the X-axis is the logarithm between S2 and S3.*

SURFICIAL GEOLOGY

Seven major map units have been defined (Figure 5). These are: glacigenic, organic, bedrock, glaciofluvial, marine, colluvial, and fluvial units. These are discussed below in order of diminishing areal importance.

Glacigenic Units

Units determined to be of glacial origin are the most common surficial materials, covering approximately 70 percent of the land area and occurring extensively throughout. Sections occur commonly in road cuts, ditches, and on abandoned sawmill or construction sites.

Seventeen diamicton exposures investigated in detail were determined to be of glacial origin. These exposures are between 1 and 4 m in height. They tend to be represented by cuts in the sides of hummocks, or are restricted to bedrock-controlled topographic lows. Generally, the diamictons are clast dominated and structureless, although lenses of coarser or finer material are evident at some locations. Clasts are often striated, and bullet and barrel shapes are common. Fabrics from these sections generally have strong orientations with principal eigenvalues between 0.5 and 0.8. Some K-values are high, (greater than 1), but most are below 1.

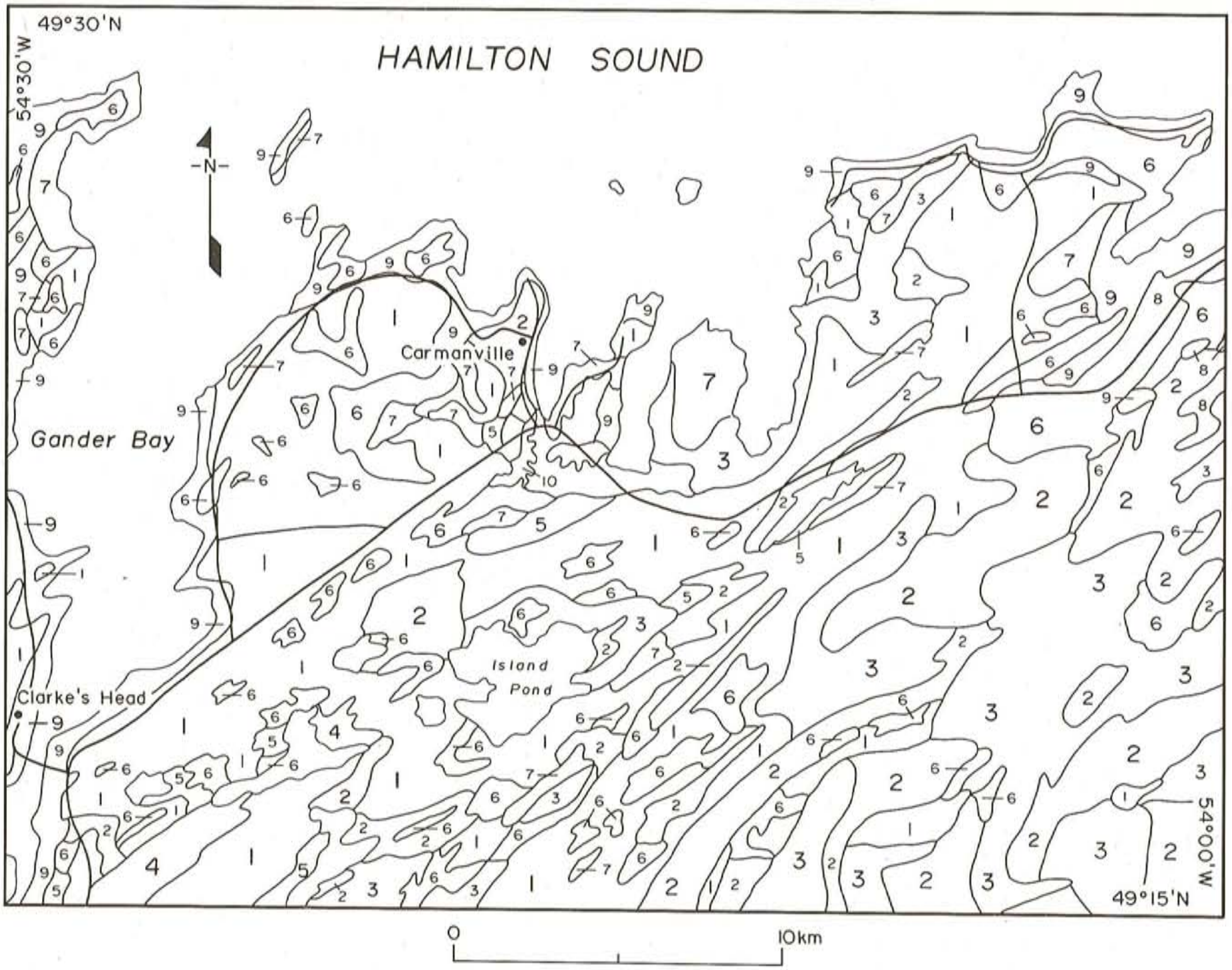
Till veneers and eroded till veneers (1) are the most extensive surficial glacigenic units in the map area, constituting approximately 35 percent of the total land area (Figure 5). They occur most extensively near Fredrickton and Carmanville. Vertical exposures are rare and where encountered are 1 m or less thick.

Hummocky till (2) is the dominant sediment type over approximately 20 percent of the land area (Figure 5). It occurs most commonly in the interior of the study area but extends close to the shore near Carmanville and Musgrave Harbour. Fifteen of the diamicton exposures observed occur in this hummocky till belt. Hummocks are 10 m or less high and are up to 100 m in diameter. They are generally restricted to topographic lows.

Ridged till (3) covers approximately 15 percent of the land area and may be equated with moraines (Figure 5). It is generally restricted to the interior, and occurs commonly in conjunction with hummocky till deposits. In Eastern Arm and Middle Arm, till ridges are evident as linear islands, composed of relatively coarse cobbles and boulders that are now exposed due to marine erosion. Similar moraines can also be recognized at Aspen Cove. These features are probably rogen or cross-valley moraines, which form transverse to ice flow (Shaw, 1979), and thus reflect the northeastward ice flow.

Lineated till (4) occurs only at one location, directly to the west and southwest of Island Pond (Figure 5). It covers less than 1 percent of the land area and is in the form of drumlinoid features and flutings. These are between 150 m and 800 m long and rarely exceed 20 m in height. They are oriented northeast, reflecting the northeastward ice flow.

Eroded till (5) has not often been recognized as a distinct unit in the map area (Figure 5). Most often the eroded till units are referred to as eroded till veneer (1), eroded hummocky till (2), eroded ridged till (3), and eroded lineated till (4).



1. Till veneer
2. Hummocky till
3. Ridged till
4. Lineated till
5. Eroded till
6. Organic
7. Bedrock
8. Glaciofluvial
9. Marine
10. Colluvial

Figure 5. *Surficial geology of the Carmanville (NTS 2E/8) map area.*

A good exposure of glacigenic sediment is Site 30 located on Route 330. It is part of a low-lying hummock. The section is approximately 3.5 m high, displaying 2.5 m of exposed sediment. Three main units are evident (Figure 6) making the site atypical of all other exposures in the area.

The basal unit is a 25-cm-thick, very compact, dark olive-grey (Munsell-5Y 3/2, moist), matrix-dominated (20 percent clasts) diamicton containing striated clasts. Exposure of the unit is poor, therefore, fabric analysis was not undertaken. This is overlain by a 165-cm-thick unit of granule gravel, which generally fines upward and contains some small-scale trough bedding. Overlying this is a 75-cm-thick, moderately compact, light olive green (Munsell-5Y 4/4, moist), matrix-dominated (15 percent clasts) diamicton. Bullet-shaped and striated clasts are common. Fabric analysis shows the clasts to have a strong southeast to northwest trend with a principal eigenvalue of 0.723 and a K-value of 1.76.

On the basis of the presence of striated clasts, the lower unit has been interpreted as being of glacial origin. The upper unit also has many striated clasts and has strong S1 and high K-values. Clast fabric suggests it is a basal till deposited by the northwestward-moving ice. Whether both diamictons were deposited by the same ice flow is difficult to determine and depends on the interpretation of the intermediate unit and the examination of the clast lithology of the two diamictons. The presence of trough crossbedding indicates that the intermediate unit was formed by current flowing water, but whether this was formed subglacially or subaerially has not been determined as yet.

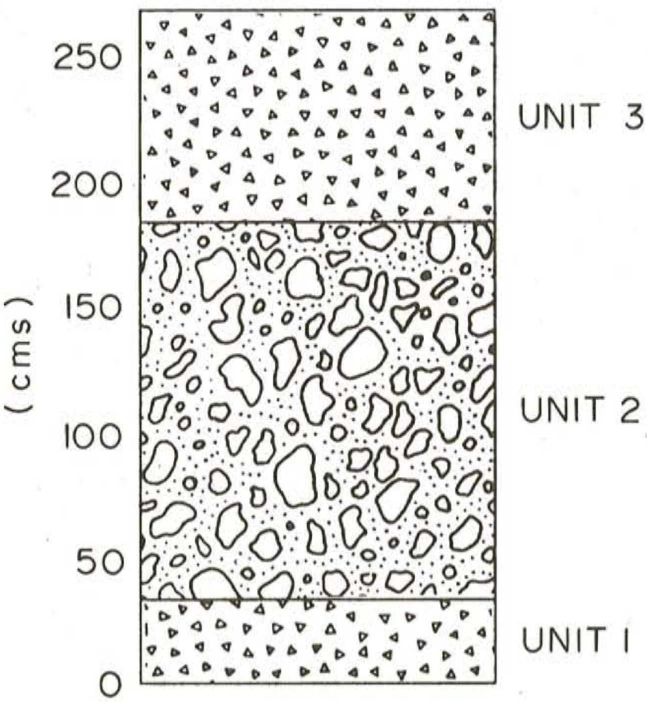


Figure 6. *Generalized stratigraphy of Site 30.*

The basal unit has approximately 30 percent greenschist, 25 percent basalt, and 20 percent ultramafic rocks. Other rock types include minor amounts of slate, quartz, granite, and diabase. The ultramafic rocks have their origin in the GRUB and greenschists occur to the southeast of that belt. Consequently, this lower unit was also deposited by northwestward moving ice that crossed the metamorphosed area and then crossed the GRUB. The lithology of the upper unit is similar to this lower unit with approximately 40 percent ultramafic rocks, 20 percent greenschist, 10 percent basalt, and minor amounts of greywacke, quartz and siltstone, confirming this interpretation.

Organic Units

Organic areas (6) cover approximately 15 percent of the surface map area (Figure 5). They occur throughout the area and are recognizable as flat marshy areas, often in the form of string bogs or aapa with fibric peat as the most common surficial material. Organic units commonly overlie marine deposits and consequently occur more commonly at elevations below the marine limit (67 m). Exposures at Ladle Cove and south of Musgrave Harbour indicate that these deposits are typically between 0.5 m and 1.5 m thick.

Bedrock

Exposed bedrock or bedrock covered by vegetation (7) covers approximately 10 percent of the land area (Figure 5). It is most prominent around the coastline where vegetation cover is thin. The geomorphology of many parts of the map area is controlled by the underlying bedrock form.

Glaciofluvial Units

Glaciofluvial sand and gravel deposits (8) are restricted to the northeast part of the map area, directly west of Musgrave Harbour (Figure 5). They occupy a small area 12 km^2, which is approximately 1 percent of the land area. Generally, hummocky terrain dominates, with marine deposits occupying depressions. The glaciofluvial deposits within this area are texturally and structurally variable. Horizontally bedded, finely laminated clays, silts and sands (Plate 2) are found adjacent to sharply contrasting steeply dipping thick beds of cobbles. Deformation in the finer silts and sands is common (Plate 3), particularly where overlain by thick gravel deposits.

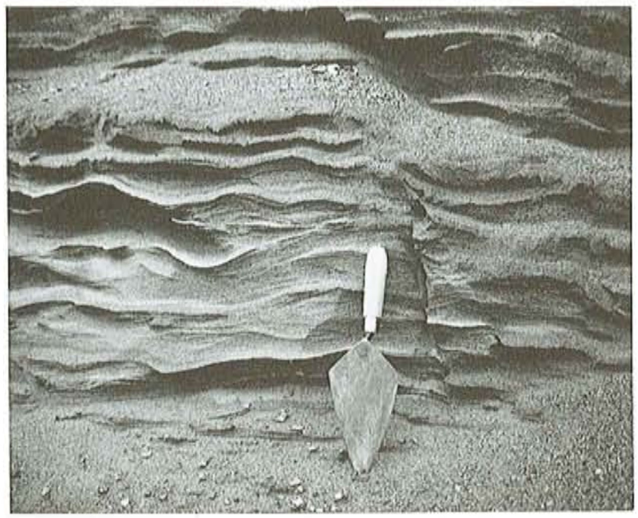


Plate 2. *Rippled silts and sands (Site 4; section 8).*

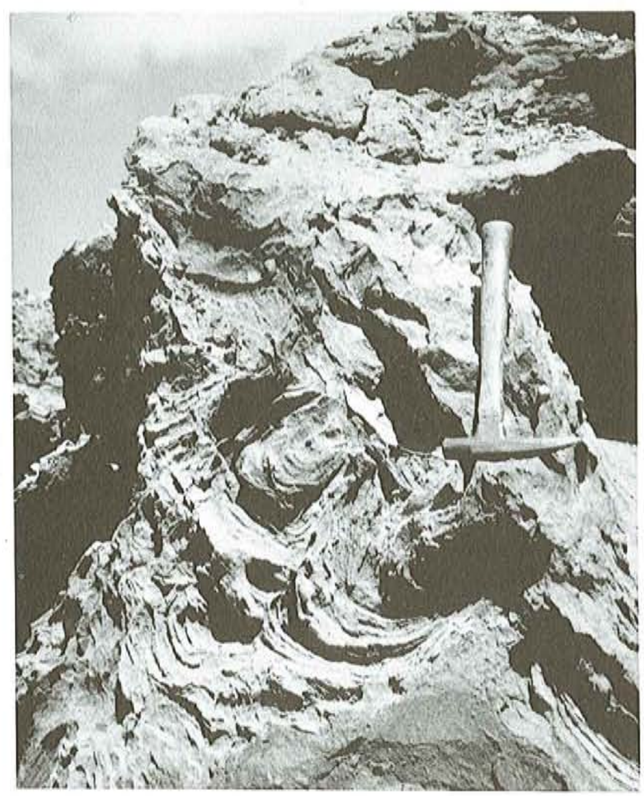


Plate 3. *Deformation of silts and sands (Site 4; section 2).*

At elevations up to 40 m, the surfaces of these deposits have commonly been reworked by marine action, resulting in the deposition of marine beach gravels in the form of terraces. Beach sediments represent a maximum of the uppermost 1m of the exposures.

Marine Units

Marine deposits (9) occur up to elevations of 57 m asl, although erosional platforms occur to elevations of 67 m asl (Figure 5). Exposed marine units occur in the form of gravels at four principal locations: Aspen Cove, Noggin Hill, Wing's Point, and Victoria Cove. These areas are currently being exploited for aggregate. These deposits are well sorted and vary from granules to cobbles.

A series of marine terraces in the Wing's Point area can be seen on the aerial photographs. These reach maximum elevations of 51 m asl. A good exposure occurs at 32 m asl at Wing's Point where over 3 m of gravels are seen overlying bedrock. These terraces extend laterally for 2 to 3 km. Over 4 m of gravels are exposed at Victoria Cove at an elevation of 11 m asl (part of a lower elevation terrace). It is possible that similar thicknesses of gravels may be present at Noggin Hill and Ladle Cove at similar elevations.

Colluvial Units

Colluvium (10) is not a common sediment type in the map area, covering less than 1 percent (Figure 5). This is because of the lack of steep slopes on which mass movement can take place. It is found near Carmanville and Carmanville South, and on Route 330 near the Aspen Cove exit, as fan-shaped lobes at the base of slopes. The sediment commonly contains striated clasts suggesting an original glacial origin. Although diamictic, the sediment varies considerably from the local basal till. In general, it is much more compact, the clay content is higher, and slump structures are evident. Fabrics from these deposits commonly have girdle distributions, eigenvalues range from 0.434 to 0.558, and K-values are always less than 1.

Fluvial Units

Fluvial deposits cover less than 1 percent of the surface area. They are present along the banks of the Ragged Harbour River on the modern flood plains. Often these are covered by thin organic veneers. Characteristically, these are made up of fine clays and silts, as reflected in the present poor drainage of the area.

SUMMARY AND CONCLUSIONS

The Carmanville area has been subjected to at least three ice-flow events, which have resulted in a range of deposits. Striations confirm that the first ice flow was an eastward flow. The second ice flow was in a northeastward direction. From the presence of drumlins on the sea floor at the head of Gander Bay, and the presence of Rogen moraines in Hamilton Sound, it is apparent that this ice extended offshore. The third ice flow was in a northwesterly direction. This ice extended across the whole map area, as striations, indicating this flow orientation, occur along the coast. Some glacial diamictons have easterly trends and some have northerly trends, showing that all three ice flows have played a role in forming the present dispersal pattern of material.

During retreat there was a period of ice stillstand in the area south of Aspen Cove resulting in the formation of hummocky outwash. It is likely that these deposits are related to the final northwesterly event as they are well preserved.

Following deglaciation, complex changes in sea level occurred. Sea levels reached a maximum of at least 67 m asl, as indicated by erosional platforms measured at Noggin Hill. This is 27 m higher than Grant's (1989) 40 m limit. A marine limit of 75 m has been reported west of the map area at Springdale (Tucker, 1974; Scott *et al.*, 1991). Sea levels dropped to elevations of at least 41 m asl some time after the deposition of the glaciofluvial deposits. Subsequently, marine reworking modified the upper units of the glaciofluvial deposits. Samples of wood and peat were taken from elevations of 7 m and 41 m respectively at Ladle Cove and south of Ragged Harbour directly overlying marine units and have been submitted for ^{14}C dating. These dates will help in constraining the chronology of sea-level changes in the area.

IMPLICATIONS FOR MINERAL EXPLORATION

The dominant ice flow producing the present dispersal pattern was the northwesterly flow. Diamictons produced by this flow may contain detritus from copper mineral occurrences (such as chalcopyrite, bornite, cuprite, and covellite), pyrrotite, arsenopyrite, or geochemical signatures associated with the GRUB, reflecting dispersal to the northwest of the line in the Carmanville area. Some tills were also deposited by northeastward-moving ice in the Ladle Cove–Aspen Cove area, and offshore in that area. These sediments may therefore contain copper, nickel, manganese, and chromite mineralization associated with the GRUB, or related geochemical signatures.

Care must be taken when sampling the overburden in this area, as not all diamictons are till deposits. Fabric analysis and sedimentological investigations have indicated that some have been reworked by meltwater, some represent downwasting of ice, and some are completely reworked by colluvial activity. Primary tills in the region are marked by unimodal fabric patterns, striated clasts aligned parallel to the direction of ice flow, and low proportions (20 to 30 percent) of large clasts. Diamictons that have undergone reworking may differ in texture and consequently in mineral concentrations from the original deposit, as most minerals are concentrated in specific size fractions (Dreimanis and Vagners, 1972). Sediment cover is thin and discontinuous and in vertical section the tills are relatively homogenous, texturally and lithologically. Consequently, samples directly below the soil horizon are representative of till at depth.

Most of the till deposits lie below the marine limit. Little marine reworking is evident in the upper parts of the exposure due to the relative rapid decline of sea level prior to 8000 years BP (Shaw and Forbes, 1990). This, therefore, is not a major factor to take into consideration when prospecting in this area.

ECONOMIC AND ENVIRONMENTAL GEOLOGY

Although there are no terrestrial gold occurrences recorded from the area, an offshore placer gold occurrence has been found to the west of the study area in Dog Bay (Emory-Moore and Solomon, 1989). Therefore, the possibility of placer deposits being reworked offshore should not be discounted. The rapid decline of sea level subsequent to deglaciation, however, suggests that opportunities for marine placer formation were limited.

The possibility of finding gold traces in the tills should be good. Tills deposited by northeastward-moving ice have the potential to be relatively 'rich' in gold traces and associated geochemical anomalies, as the northeastward moving ice flow would have to have crossed both the GRUB and the Davidsville Group, both of which contain gold-bearing rocks.

Most aggregate sources in this area are presently being exploited, or the potential for exploitation has been assessed (Kirby and Ricketts, 1983). A possible new source for aggregate lies on the eastern shore of Noggin Hill. Its aspect is similar to Wing's Point and Aspen Cove, and marine terraces are present up to elevations of approximately 40 m asl. The development of beaches at this location was accompanied by extensive reworking and sorting of coarse gravel and as a result, several metres of sediment may be available for exploitation.

Fibric peat, derived from fen vegetation, occurs throughout the region. Most peat deposits, although laterally extensive, are not thick (0.5–1.5 m) and exploitation for agricultural, fuel or other purposes is unlikely to be economically viable.

All sediment in the area is relatively stable, and not subject to colluviation, except along the steepest slopes. Therefore, the compact diamictons and gravelly sediments pose no hazards for construction.

Sediments throughout the area are generally unsuitable substrates for waste disposal. Most of the sediments in the area are relatively coarse, and hence are porous and permeable. Percolation of liquid waste materials would be rapid. As surface aquifers are extensively used throughout the region as water sources, waste disposal in landfill is likely to lead to serious groundwater contamination.

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