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QUATERNARY GEOLOGY OF THE KING'S POINT MAP SHEET (NTS 12H/9)

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ABSTRACT

The King's Point map area (NTS 12H/9) is located in north-central Newfoundland. A surficial geology map has been prepared and it shows that thick sediment cover is restricted to the south and west of the map area. Till is common, and is probably mainly deposited by basal melt-out processes. Some till deposits have been extensively reworked by either subglacial or proglacial meltwater. Sand and gravel deposits include eskers, kames, deltas, and outwash. Two ice-flow events affected the area: an early northward flow, and a later eastward to southeastward flow. Pebble lithology and clast orientation data indicate that the latter flow dominated glacial sediment dispersal.

INTRODUCTION

The King's Point map area is located in north-central Newfoundland, and covers the southeastern Baie Verte Peninsula, and the area between King's Point and Springdale (Figure 1). This area has been the site of several mining operations in the past, and is now of considerable interest to mineral exploration with gold being the primary target. Exploration techniques include soil sampling and boulder tracing. These methods require an understanding of the genesis of surficial sediment, and ice-flow history. This project was initiated to better define the Quaternary geology in order to improve the efficiency and effectiveness of drift exploration.

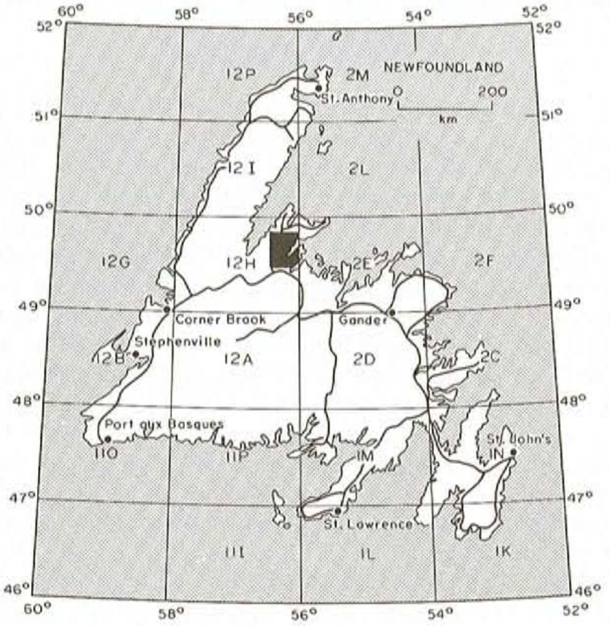


Figure 1. *Location map, King's Point map sheet.*

Reconnaissance work in 1988 indicated that the King's Point area has a thick drift cover and a complex ice-flow history and therefore, it was chosen for detailed mapping in 1989. The objectives for the 1989 field season were to ground-check aerial photograph interpretations of surficial geology, to supplement existing ice-flow data, to describe the sedimentologic properties of surficial sediment, and to undertake a program of detailed sampling of the surficial sediment in order to investigate sediment provenance.

Physiography

The map sheet consists of three highland areas separated by three linear lowland areas. The lowlands are largely controlled by major faults and lineaments in the bedrock, rather than being the sites of river systems. The lowland areas are, from west to east, the Mic Mac Lake–Flatwater Pond lowland; the Shoal Pond–King's Point lowland, and the Indian Brook–Springdale valley lowland (Figure 2). The plateau areas have a rugged topography, and lie at altitudes between 100 and 400 m a.s.l. The coastline consists of major inlets of Green Bay, with Southwest Arm, and Middle Arm being prominent. The shoreline is generally steep, having cliffs rising 50 to 100 m. Apart from Indian Brook, no major streams or rivers exist, but ponds and lakes are common, the largest being Mic Mac Lake, Gull Pond and Wild Cove Pond (Figure 2). Drainage patterns are mostly random, although in some areas a rectangular pattern can be seen, probably controlled by bedrock lineaments.

Bedrock Geology

The bedrock of the King's Point area can be described simply by a division into four zones, each incorporating a number of geological units (Figure 3).

Zone 1: Humber Zone rocks of the Fleur de Lys Supergroup and the Wild Cove Pond igneous suite are found west of the

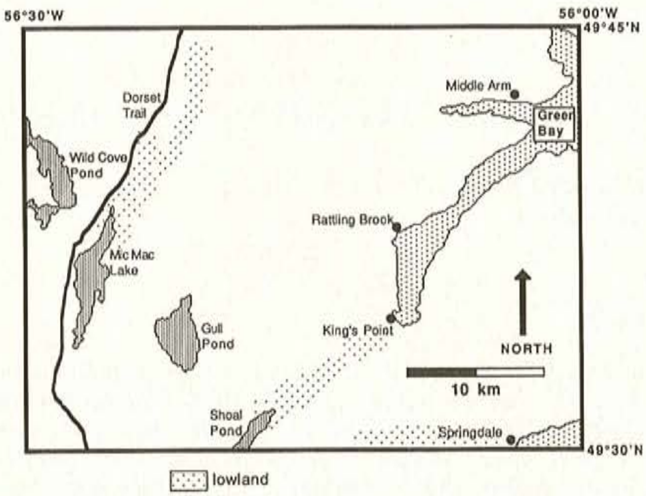


Figure 2. *Locations of features named in text.*

Dorset Trail (Figure 2). The Wild Cove Pond igneous suite consists mainly of granite and granodiorite, associated with minor gabbro and gneiss (Hibbard 1983, 1989). The Fleur de Lys Supergroup consists of psammitic and semipelitic schists. The Baie Verte Line forms the eastern boundary of the Humber Zone, and runs southwest–northeast, close to the Dorset Trail.

Zone 2: East of the Baie Verte lineament, Dunnage Zone rocks of the Flatwater Pond Group, Advocate Complex and Mic Mac Lake Group are exposed as a northeast–southwest-trending belt 3- to 8-km wide. The Flatwater Pond Group consists of diabase dykes, pillow lavas, flow lavas, and pyroclastics, and the Advocate Complex consists of ultramafics and gabbroic intrusions. The Mic Mac Lake Group consists of subaerial silicic volcanic and pyroclastic rocks, and minor sandstone and conglomerate (Hibbard, 1983, 1989).

Zone 3: The central part of the map sheet area is dominated by two major intrusions; the Burlington Granodiorite, and an unnamed quartz feldspar porphyry. Minor intrusions of diorite, monzonite and gabbro outcrop southwest of Gull Pond; and in the area of Middle Arm, a fine grained granite–syenite is found (Hibbard, 1983, 1989).

Zone 4: The Green Bay Fault separates the above rocks from rocks of the Catchers Pond, Western Arm, Lushs Bight, and Springdale groups, which form the bedrock to the southeast. The Catchers Pond Group is dominated by acidic volcanic rocks, and the Western Arm Group contains pillow lavas, tuff, agglomerate and breccia. The Lushs Bight Group contains pillow basalt, breccia, tuff, chert, diabase dykes and gabbro. The Springdale Group is composed of conglomerate, sandstone and mudstone (Dean, 1977; Kean, 1977).

Previous Work

Lundqvist (1965) examined striae over a wide area of north-central Newfoundland and suggested that major ice-flow was from southwest to northeast. During deglaciation, local topography became increasingly important and gave rise to considerable variation in flow direction. Tucker (1973) examined striae to the south of the field area, as did Alley and Slatt (1975). These more detailed studies generally supported the ice-flow history of Lundqvist (1965).

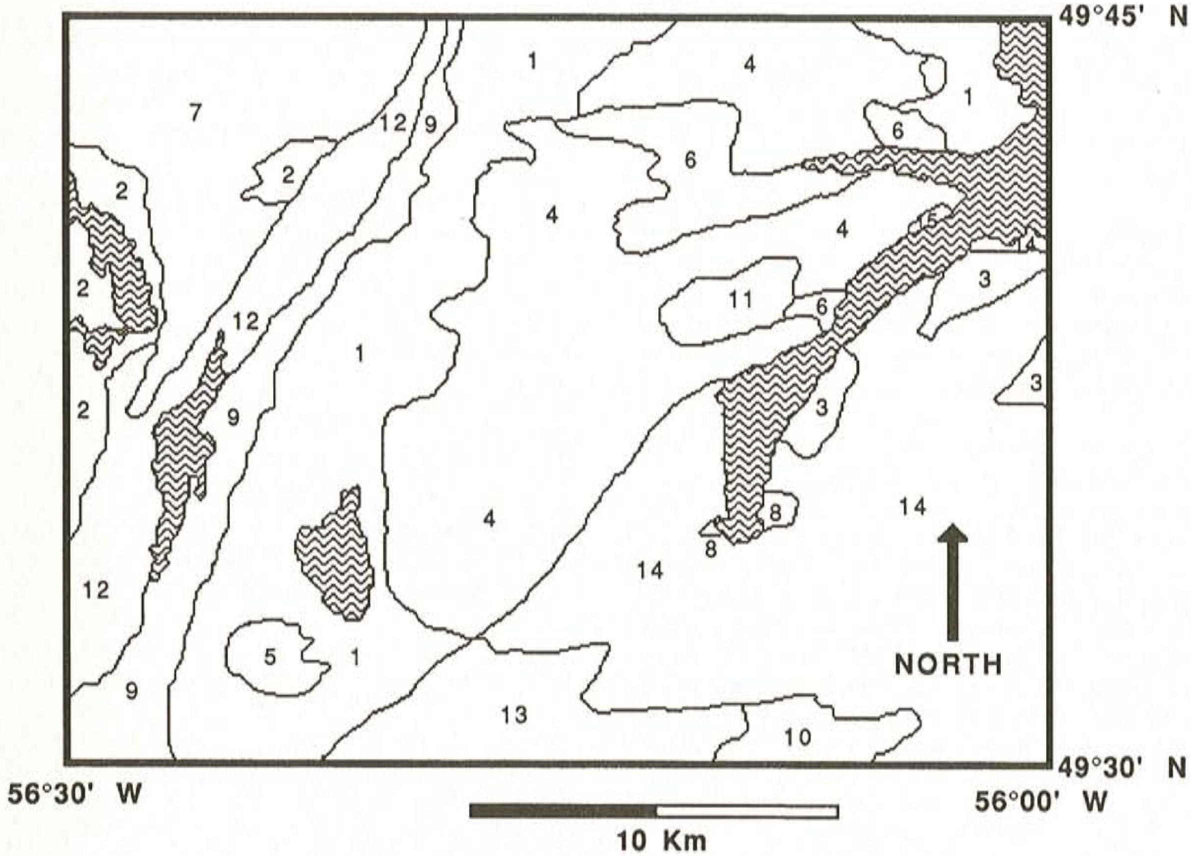
Tucker (1974) described sediments deposited in ice contact deltas at Springdale, which define a marine limit of approximately 75 m a.s.l. Mollusc shells collected from marine clays gave a radiocarbon date of 12,000 ± 200 BP (GSC-1733), thought to represent a minimum date for deglaciation (Tucker, 1974). Alley and Slatt (1975), who studied the southern margin of the map sheet reported two till units in backhoe pits, that they related to distinct ice-flow events.

Blake (1987) reported radiocarbon dates of 11,800 ± 200 BP (GSC-3957) and 10,300 ± 170 BP (GSC-3958) on bulk organics from lake sediments collected from a small lake 8 km south of King's Point. Macpherson (in Blake, 1987) comments that the older date is from the base of the core, and represents a minimum date for deglaciation, whereas the younger date marks the initial rise of Picea (spruce) pollen in sediments. Other radiocarbon dates on shells from Middle Arm, Rattling Brook, South Brook (southeast of the map area) and King's Point are in the range 11,700–12,000 BP (GSC-75, 87, 2085, 4311; reported in Dyck and Fyles, 1963; Lowdon and Blake, 1975; and Blake, 1986, 1988 respectively).

The King's Point map sheet has been mapped on a reconnaissance level at 1:50,000 by Grant (1986), mainly by aerial photograph interpretation, but with some ground checking. Liverman and St. Croix (1989a, b) suggested that ice-flow was more complex than previously thought, with numerous examples of crossing striae being found in the area.

FIELD METHODS

Access to most of the area is good to fair, on paved and unpaved roads and tracks, apart from an area lying northwest of King's Point and Rattling Brook, and south of Middle Arm, which is only accessible by helicopter. Road work was supplemented by boat travel on Mic Mac Lake, and by limited foot traverses. Striae and other ice-flow indicators were located and recorded. Natural sections, roadcuts, gravel pits and other exposures were examined and described when encountered. In areas of limited exposure, pits were dug by hand. A backhoe program resulted in detailed examination of 12 pits, exposing up to 3 m of sediment. In poor exposures and hand-dug pits, the sediment was described and the C-soil horizon was sampled for texture, geochemistry, and clast lithology. In better exposures and backhoe pits, routine sampling was supplemented by detailed description and clast orientation measurements. In total, over 200 samples were collected, and will be submitted for textural and geochemical analysis. The lithology of 100 or more clasts from each of 150 samples was determined in the field. Forty clast-fabric determinations were made, with 25 elongate clasts measured at each.



LEGEND

- 1 Burlington Granodiorite
- 2 Wild Cove Pond igneous suite (granite, granodiorite)
- 3 Colchester Pluton (granite)
- 4 Porphyry (Cape Brule equivalent)
- 5 Gabbro (unnamed)
- 6 Granite (unnamed)
- 7 Fleur de Lys Supergroup (schists)
- 8 Carboniferous sandstones
- 9 Mic-Mac Lake Group (felsic volcanoclastics, rhyolite)
- 10 Springdale Group (sandstone, conglomerate, mudstone)
- 11 Cape St. John Group equivalent (felsic volcanics)
- 12 Advocate Complex/ Flatwater Pond Group (ultramafics, mafic volcanics)
- 13 Catchers Pond Group (felsic volcanics)
- 14 Lushs Bight Group (mafic volcanics)
- 15 Betts Cove Complex (mafic volcanics, ultramafics)

Figure 3. *Bedrock geology, King's Point map sheet, adapted from Hibbard (1983) and Kean (1977).*

SURFICIAL SEDIMENT

Figure 4 is a sketch map of the surficial geology. At this scale of mapping, only the dominant sediment type is represented on the map. In practice, the surficial sediment is variable, with each unit mapped in Figure 4 containing lesser amounts of other sediment types. Eight major units are identified.

Unit 1 (bedrock): This unit consists of bedrock, either exposed or concealed by soil development and vegetation. It constitutes over 50 percent of the map area, and between 70 and 80 percent of the eastern half of the map area. Patches of sediment (till veneer, sand and gravel, bog) are common within this unit but form less than 50 percent by area.

Unit 2 (till veneer): This unit consists of a discontinuous sheet of till, less than 1.5-m thick. It forms 20 percent of the map area. It is interspersed with areas of bedrock and thicker surficial sediment, but forms more than 50 percent by area of the mapped unit. The unit is composed of diamicton (a poorly sorted sediment containing a wide range of grain sizes from clay to boulders), with 50 to 70 percent clasts (>2 mm in diameter), and a matrix dominated by sand. Maximum clast sizes are in the order of 1 to 2 m in diameter. Clast lithology is mainly local, with local bedrock composing 50 to 80 percent. The diamicton is usually massive, although laminae and lenses of silt, sand, and gravel are rarely present. No clast orientation measurements were made on this unit.

The absence of fabric measurements from this unit makes interpretation of environment of deposition speculative. Fabric evidence from thicker exposures of diamicton associated with till veneer is variable, but generally shows either unimodal, moderately to strongly oriented fabrics, or weak to moderate girdle fabrics. The presence of sorted strata in some exposures combined with well oriented fabrics, and local provenance, suggests basal melt-out deposition (Lawson, 1979; Haldorsen and Shaw, 1982; Shaw, 1982, 1987), but it is likely that the unit is polygenetic, with some parts deposited by lodgment, or mass movement.

Unit 3 (hummocky till): This unit consists of a blanket of greater than 1.5-m thickness of diamicton, with a hummocky surface topography. It is found along the Mic Mac Lake lowland, and adjacent to Wild Cove Pond (Figure 4), and constitutes less than 10 percent of the map area. The surface relief is from 2 to 10 m, and the hummocks are from 50 to 300 m in diameter. The composition of the hummocks is diamicton, similar to that of the till veneer, with boulders up to 2 m in diameter, set in a sand dominated matrix. Clasts are dominantly of local provenance. Good exposures show laminae of sand and silt, and lenses of gravel (Plates 1 and 2). Clast fabrics are variable both between and within sites (Figure 5), ranging from well oriented, unimodal, to poorly oriented girdle or polymodal.

Poorly sorted sediment deposited as a blanket is most likely a till. Such material may be deposited subglacially (basal melt out, lodgment), supraglacially (supraglacial melt out), or proglacially (rain-out diamicton, sediment flows). Basally deposited tills are characterized by moderate to strong, unimodal or bimodal clast fabrics, whereas other environments generally show weak to moderate girdle or polymodal fabrics (Lawson, 1979; Shaw, 1982; Domack and Lawson, 1985; Rappol, 1985; Dowdeswell and Sharp, 1986). Given the variable fabrics from the same stratigraphic level in a given site, it is likely that weaker fabrics result from postdepositional modification of well oriented fabrics by mass

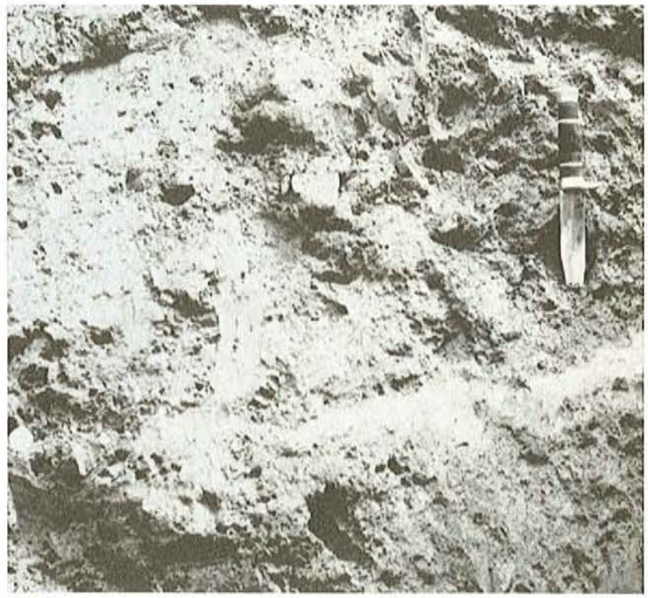


Plate 1. *Diamicton of Unit 3 exposed in backhoe pit. Note bed of well sorted sand below knife.*

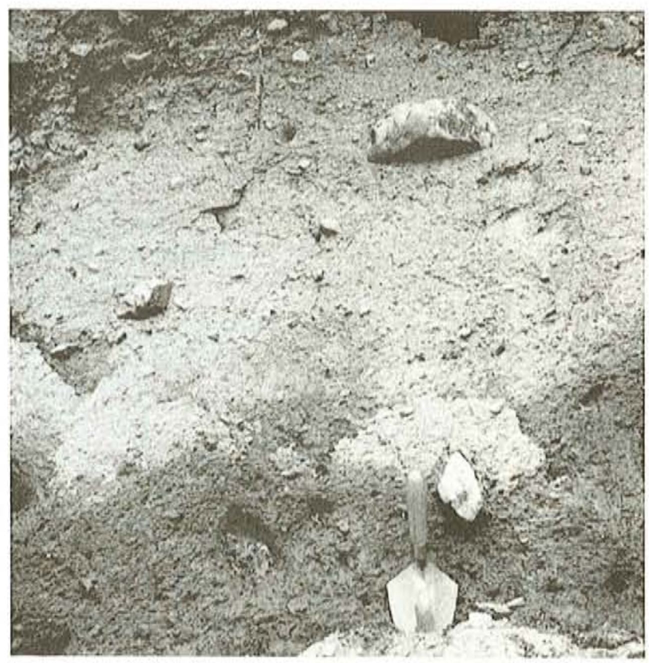


Plate 2. *Typical massive diamicton of Units 2, 3 and 5.*

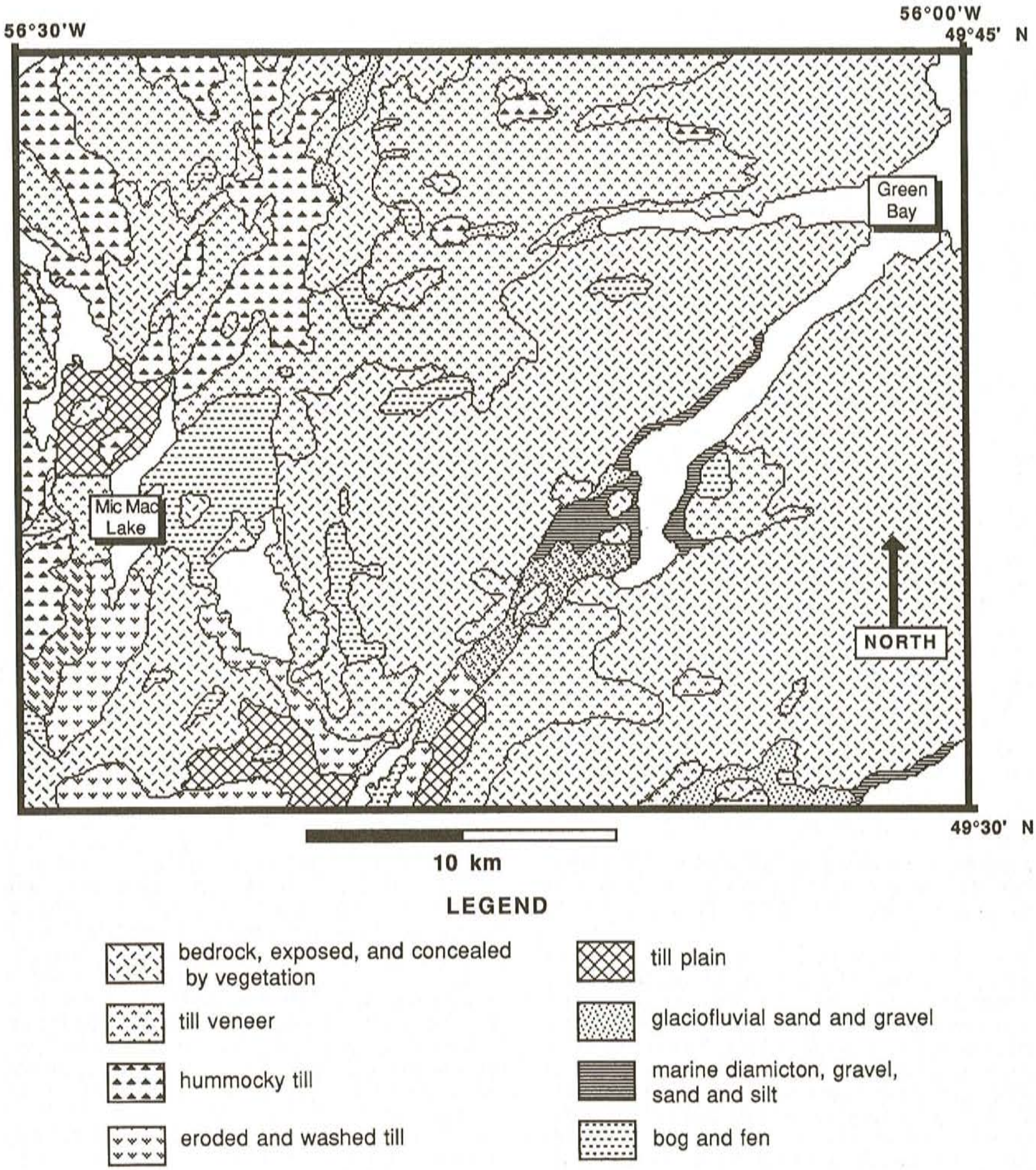


Figure 4. *Surficial geology, King's Point map sheet. Only the dominant surficial sediment type is denoted for a given map unit.*

movement processes. Thus, it is likely that the sediment was originally deposited basally. The common sorted strata indicate deposition by basal melt out rather than lodgment (Shaw, 1982). Hummocky surface topography is thought to be developed during ice stagnation, although the exact process is unclear. Hypotheses include topographic inversion (Gravenor and Kupsch, 1959), or injection into subglacial cavities (Stalker, 1960). Both these processes could result in a modification of a well oriented fabric.

Unit 4 (eroded and washed till): This unit consists of a blanket of till that has been modified by current flow. It

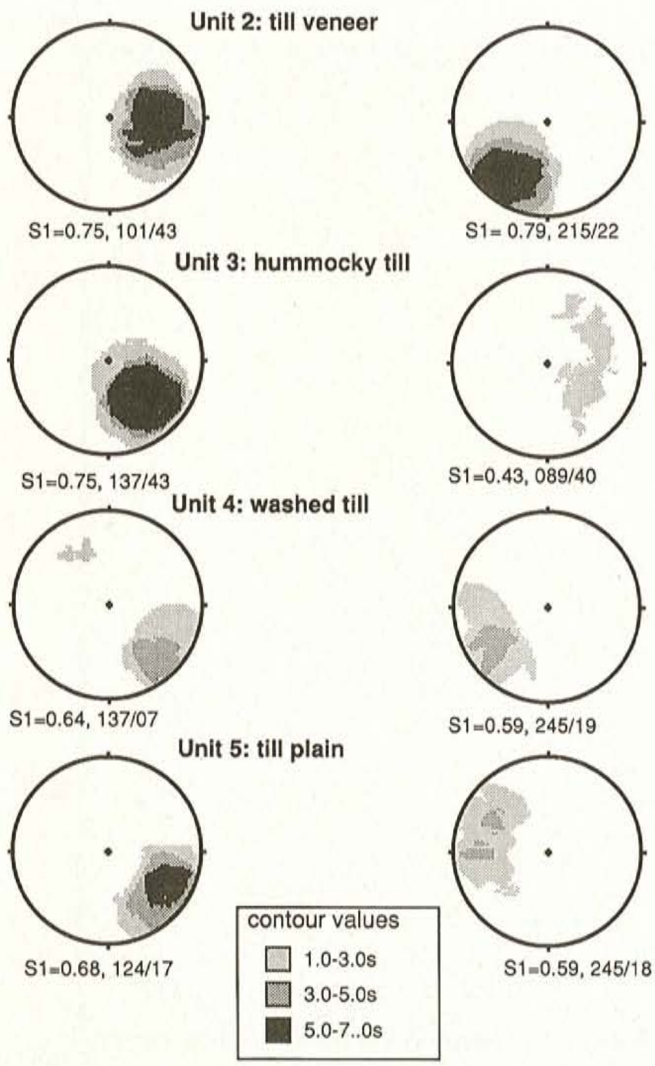


Figure 5. *Typical clast fabrics from diamictons, King's Point map sheet. For each fabric, the strength and orientation of the normalized principal eigenvalue (SI) is given.*

constitutes less than 5 percent of the map area, and is found mainly in the southwest part of the map area. In section, it is between 0.5- and 3-m thick, and consists of roughly bedded sand with many gravel sized clasts, overlying a massive diamicton or directly over bedrock. Clasts are mainly of local provenance and some are striated and faceted. The relationship of clasts to stratification is unclear, but examples of deformation of stratification under clasts, and intersection of undeformed stratification by clasts were noted. The proportion of silt- and clay-sized material is low (<5 percent). Clasts range from 2 mm to 1 m in diameter, and are in some areas concentrated at the surface. The proportion of clasts ranges from 20 to 80 percent. Clast fabrics from this unit show moderately to well oriented, unimodal distributions.

The grain-size distribution and stratified nature of the sediment indicate deposition by current flow. The numerous coarse clasts, possessing a significant preferred orientation (usually parallel to nearby striations) suggest deposition in the glacial environment. A possible genesis for this unit is primary glacial deposition as a basal till, probably by basal melt out, with secondary reworking by moderate current flow that winnowed fines, but was not sufficiently powerful to move or re-orient pebble-sized clasts. The current reworking might have occurred subglacially, or following deglaciation. Subglacial current reworking is considered more likely in most cases where the coarse clasts are distributed sporadically throughout the sediment, rather than concentrated at specific horizons, or forming lags. It also explains the clast/stratification relationships observed, as deformation of stratification would result when clasts were dropped from the base of the ice sheet into the sediment, whereas intersection with no deformation would occur by reworking of sediment following deposition. Thus the proposed environment is of basal deposition, by a combination of basal melt out and current activity. In some areas, however, where a relatively thin layer of sand-dominated sediment overlies massive diamicton, and distinct channels can be seen on aerial photographs, it is likely that current reworking occurred after deposition of basal till, following deglaciation.

Unit 5 (till plain): This unit consists of a blanket of diamicton greater than 1.5-m thick, having a smooth surface topography. It forms less than 5 percent of the map area, and is found adjacent to Shoal Pond and Wild Cove Pond. In section, it resembles Unit 3, and is a diamicton having strata and lenses of sorted sediment. Fabrics also show a similar pattern to Unit 3, with variation from moderate to strong within and between sections (Figure 5). Clasts are mostly of local provenance.

The resemblance to Unit 3 suggests a similar origin, with deposition primarily by basal melt out, but with some postdepositional modification.

Unit 6 (glaciofluvial sand and gravel): This unit consists of sand and gravel deposited in a proglacial or subglacial setting. It constitutes less than 5 percent of the map area. Two types of deposit are represented by this unit. West of Springdale, between Shoal Pond and King's Point, and on the north edge of the map area, large areas of moderately to well sorted gravel and sand with a flat channeled surface topography are found. Maximum clast sizes are cobbles, with few boulders. Sections show the sediment to be mainly horizontally stratified or trough cross-bedded. These were deposited in braided outwash plains in proglacial settings. The second deposit type is represented by sinuous ridges and mounds of poorly sorted gravel and sand (Plate 3). Clasts range from granules to boulders, with 10 to 40 percent sand. Sections show well developed planar bedding, but it is often deformed and dipping at steep angles. These sediments were deposited as eskers and kames in ice marginal or subglacial settings. Eskers are all east–west oriented.

Unit 7 (marine diamicton, gravel, sand and silt): This unit is found adjacent to the present coastline at elevations up to 75 m a.s.l. Its composition is varied. The most common surficial sediment is moderate to well sorted gravel and sand found in marine terraces at a variety of elevations along

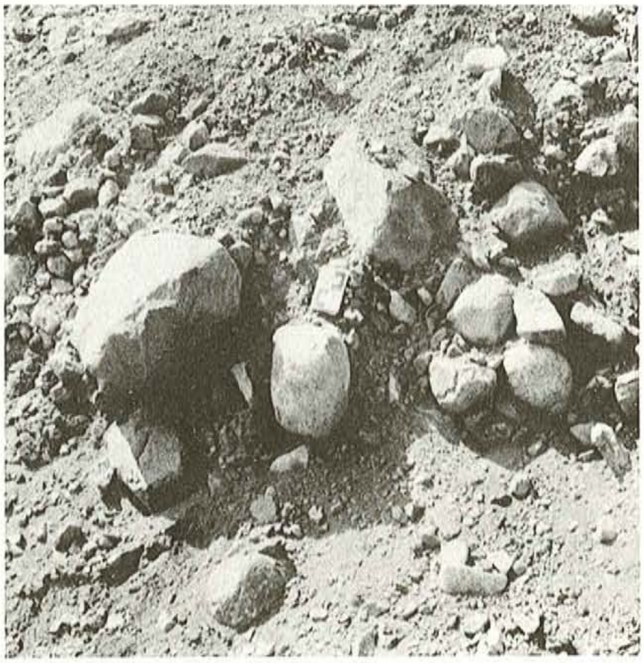


Plate 3. *Poorly sorted gravel of Unit 6, exposed adjacent to Shoal Pond. Some exposures of Unit 4 show similar characteristics.*

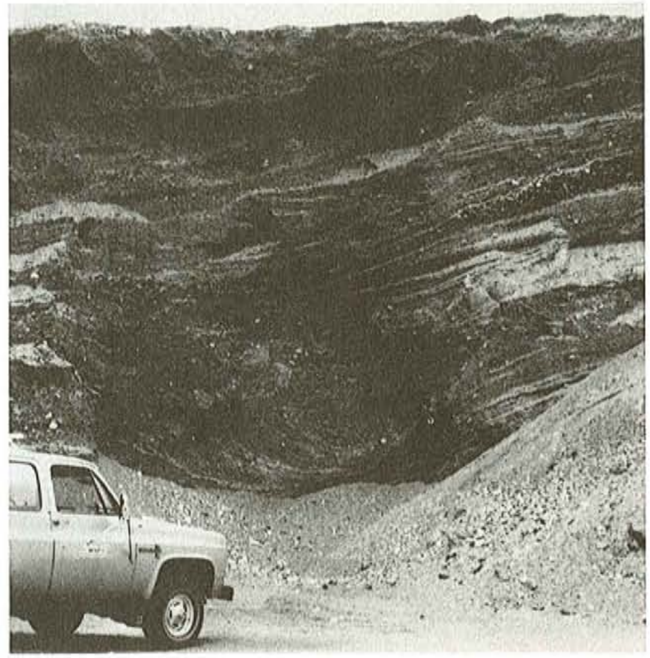


Plate 4. *Foresets of sand and gravel exposed in a raised delta at King's Point.*

Southwest Arm and Middle Arm, and the large deltas/fan deltas at Springdale and King's Point (Plate 4). The deltas were formed at the ice margin during deglaciation (Tucker, 1974), and the marine terraces were formed by wave activity during still-stands of sea-level fall due to isostatic rebound. Isolated exposures of diamicton, interbedded with poorly sorted gravel (Plate 5), are interpreted to have been deposited in ice proximal glaciomarine environments. Sections along Indian Brook, south of Springdale, show well sorted laminated and bedded silt and clay, up to 10-m thick (Plate 6). These sediments contain coarser clasts up to 40 cm diameter, that deform underlying stratification, and are draped by overlying strata. These sediments were deposited in ice distal glaciomarine environments.

Unit 8 (bog and fen): This unit consists of degraded organic matter accumulated in poorly drained areas to form bog or fen. It constitutes approximately 10 percent of the map area, and can be up to 8-m thick.

STRATIGRAPHY

Examination of natural exposures, backhoe pits and exploration trenches indicates that the stratigraphy of the area is simple. There is no evidence for multiple till units (in contrast to the findings of Alley and Slatt, 1975). In most cases, a single diamicton unit overlies bedrock. A gravel pit, close to the Dorset Trail to the north of the map sheet, shows two diamicton units overlain by sand and gravel. The lower is dominated by angular locally derived pebbles, with less than 10 percent matrix. It is interpreted as being a highly weathered bedrock surface, affected by ice thrusting. The overlying diamicton is more typical of that seen elsewhere in the area, and was probably deposited by basal melt-out processes. Thus only a single ice advance is represented in the section.

Plate 5. *Interbedded diamicton, sand, and gravel of Unit 7, exposed east of King's Point.*

ICE FLOW

Interpretation of ice-flow history over the map sheet is based mainly on striations, as larger scale oriented landforms

Plate 6. *Well sorted clay and silt of Unit 7, exposed west of Springdale. Note deformation by synsedimentary slumping.*

are rare. Two major phases of ice-flow are documented on the map sheet (Figure 6). Striations indicating a northward flow are commonly found preserved in the lee of a later eastward flow. Each of these events show some variation over the map sheet. The early northward flow varies from northwestward in the western and northwestern part of the sheet to northeastward in the area north of Springdale and east of King's Point. In this same area, the later flow is southeastward.

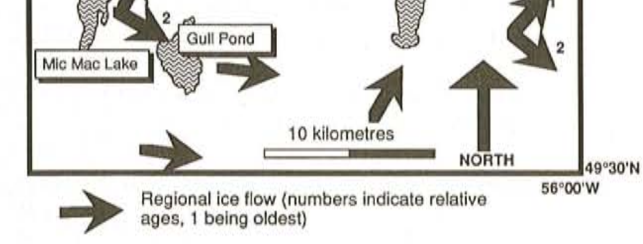


Figure 6. *Ice-flow history, King's Point map sheet.*

Ice flow can also be deduced by interpretation of clast orientation in diamictons, although caution must be exercised. Elongate clasts will align with flow lines in transporting ice and this orientation can be inherited if the clasts are deposited by basal melt-out or lodgment processes (Harrison, 1957; Lawson, 1979). Thus, the orientation of clasts in sediment (clast fabric) can be used to determine the direction of ice flow that deposited sediment. This method is particularly useful in drift prospecting in areas of complex ice flow. In such cases, there is no method of relating ice flows deduced from striation evidence to that which deposited sediment being sampled and analysed for geochemistry. Clast fabric analysis uses evidence from the same medium being sampled, and reflects the ice-flow conditions, at the time the sediment was deposited.

Caution must be used in interpretation of clast fabric analysis, as a number of processes other than glacial flow can result in a definite alignment of clasts. Thus, criteria have been developed based on statistical analysis of the data and are outlined below. Using these criteria, only 16 of the 44 samples taken are appropriate for use as indicators of ice-flow direction.

In this study, the orientation of 25 clasts with an a-axis to b-axis ratio of 1.5 or greater was measured at each site, with clasts taken from a one square metre area of a vertical outcrop face. The results were plotted on a stereogram and analysed statistically using the Stereo™ package for the Apple Macintosh computer (MacEachran, 1989). The points were contoured using the method outlined by Kamb (1959), and the principal eigenvectors and eigenvalues calculated. The principal eigenvalue divided by the sample size is known as the S1 value (Woodcock, 1977), can range between 0.33 and 1.0, and is a measure of the strength of orientation of clasts. A sample with most clasts aligned with similar orientations will have a value close to 1.0, whereas a random sample will have a value close to 0.33. Only fabrics with $S1 > 0.6$ are considered here as indicative of ice flow, as weaker orientations may be due mainly to other processes. A second statistical parameter (K) indicates whether the distribution is unimodal, or girdle (Woodcock, 1977). Low values of K (<1.0) suggest a girdle distribution, atypical of basally deposited tills, and thus, only those fabrics that show a K value greater than 1.0 are interpreted in this study as reflecting ice flow (Woodcock, 1977).

Considering only these fabrics, sediment moving ice flow in the area was generally eastward. Exception to this occurs only in the northwest of the map sheet, where fabrics suggest a northward flow. Therefore, the fabric studies support the interpretation made from striation observations.

SEDIMENT DISPERSAL

Sediment dispersal was studied by examination of clast lithology and soil geochemistry in diamicton interpreted as being deposited by glacial activity. Diamictons from 125 sites were sampled, with the objective of examining dispersal from the Baie Verte Line. The narrow belt consisting of the Flatwater Pond Group, Advocate Complex, and Mic Mac Lake Group trends southwest–northeast, and its lithology is distinct from the surrounding rocks. Therefore, sampling sites were mainly close to, or directly east of, the Baie Verte Line, with little sampling to the east of the map sheet (Figure 7). At the time of writing, geochemical results are not available, but preliminary examination of the pebble lithology data is possible.

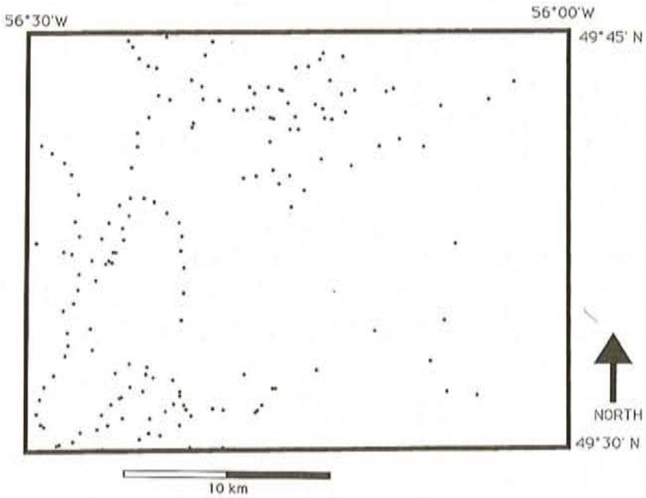


Figure 7. *Sampling points for clast lithology and geochemistry.*

At each site, between 100 and 150 clasts, ranging in diameter from 0.5 to 25 cm were collected. These were washed, cracked and identified. Most of bedrock map units in the area consist of a mixture of rock types, and petrology based on small hand specimens is difficult. Thus, it was generally impossible to relate clasts to specific bedrock sources. In analyzing the data, the clasts were grouped into various categories for the purposes of interpretation:

1) acidic- this includes granites, granodiorites, rhyolites, porphyry, and felsic volcaniclastics;
2) basic- this includes gabbro, ultramafics, basalt, and diabase;
3) ultramafic- this includes ultramafics, serpentinized ultramafics and serpentine; and
4) metamorphic- this includes mica schist, greenschist, gneiss, metagabbro, and metagranite.

Figure 8 shows contour maps based on these groupings, prepared with the Macgridzo package for the Macintosh computer (Rockware, 1986). The gridding method used considers 2.5- by 2.5-km cells, and assigns a value calculated by a weighted average of the four nearest neighbours to the cell. Such an algorithm is designed to minimize smoothing of the dataset, but may not be appropriate in areas with low sample density. Such a method is also designed for a sampling grid with even spacing. Contours in the east and southeast of the map sheet are based on a very wide sample spacing and are omitted. The diagrams presented here are a first approximation, but examination of raw data suggests that the contour plots produced accurately reflect the variation seen in samples. Comparison with maps of bedrock outcrop enables dispersion to be examined.

The contact between the Mic Mac Lake Group and the Burlington Granodiorite shows as a distinct gradient in the acidic diagram (Figure 8a), but the position of this rise in acidics is to the east of the actual contact. This is likely due to eastward dispersal of sediment by the latest eastward ice flow. Even well to the east of the contact, the maximum proportion of acidic clasts is approximately 80 percent, with 20 to 30 percent clasts of basic lithology. This may be explained by eastward or northward glacial dispersal, but it is possible that this in part relates to bedrock composition. Hibbard (1983) reports that the Burlington Granodiorite contains abundant small mafic xenoliths in some areas. The gabbro intrusion southwest of Gull Pond is shown by an eastward deviation from the southwest-northeast trend in percentage acidics.

The diagrams derived from the acidic and basic groupings mirror each other to some extnet, with high areas in one plot being matched by lows in the other. The basic contours (Figure 8b) generally do not reflect the bedrock geology as clearly as the acidic grouping. The high seen to the northwest corner, may be due to northward dispersal from the Baie Verte Line, or is due to identification of small clasts of greenschist or amphibolite from the Birchy complex as ultramafics or mafic volcaniclastics. This high is also seen in the contours of percentage ultramafics (Figure 8c), although these contours also show two highs close to the outcrop of ultramafics marked on the map of Hibbard (1983). Eastward glacial dispersal is shown by the presence of 5 to 10 percent ultramafics well to the west of their outcrop, although these may be explained in part by ultramafic xenoliths within intrusives.

The diagram contouring percentage metamorphic clasts in diamicton (Figure 8d), shows a high closely matching the outcrop of metamorphic rocks in the map area. Some evidence of eastward dispersal is seen as up to 5 percent metamorphic clasts and found in samples from east of the Baie Verte Line.

In general, these plots show that the clast lithology in diamictons is varied but mostly resembles underlying bedrock. Non-local rock types, however, account for from 20 to 80 percent of the assemblage. Dispersal by eastward-flowing ice is clear from these diagrams, but transport distances are generally short (1 to 2 km).

QUATERNARY HISTORY

The following sequence of events can be deduced from evidence presented above, and other published work. There is only stratigraphic evidence for a single glacial advance over the area, but striations indicate two clear flow events. The source of ice for these events is unclear. It seems likely that the early flow event occurred when ice centred to the south of the Baie Verte Peninsula flowed northward. The final eastern flow originated either locally from an ice cap centred on the southwest Baie Verte Peninsula, or from an ice centre in the southern Long Range Mountains of the Northern Peninsula. The orientation of eskers, combined with

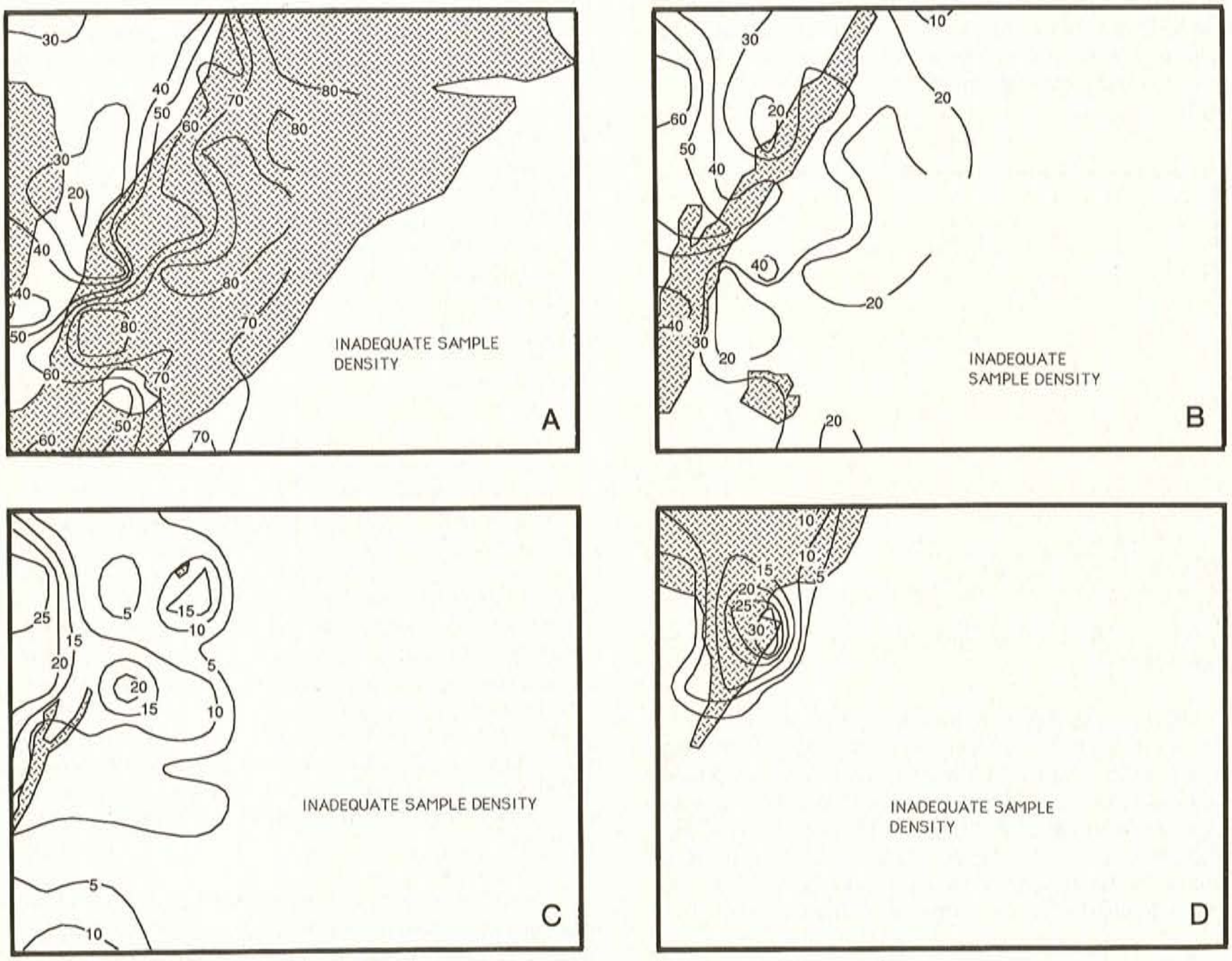


Figure 8. *Contoured plots for King's Point map sheet. Refer to Figure 7 for sample locations. Shaded areas represent outcrop of potential source rocks. 8a) percentage acidic clasts in diamictons, contour interval is 10 percent; 8b) percentage basic clasts in diamictons, contour interval is 10 percent; 8c) percentage ultramafic clasts in diamictons, contour interval is 5 percent; 8d) percentage metamorphic clasts in diamictons, contour interval is 5 percent.*

hummocky topography, suggest that this ice sheet stagnated, with an ice margin oriented approximately north–south across the map sheet, located east of Gull Pond. During deglaciation, large volumes of meltwater reworked till in the Gull Pond–Shoal Pond area, and this water flowed either out to King's Point or along Indian Brook Valley. At this time, ice contact deltas or fan deltas formed at Springdale and King's Point indicating a marine limit of 75 m a.s.l. Using the dates of Tucker (1974), Dyck and Fyles (1963), Lowdon and Blake (1975), and Blake (1988), it seems likely that this stagnation occurred at between 12,000 and 11,700 BP. The sea-level history is unclear, but glaciomarine clays in the Springdale area indicate a substantial marine incursion following ice retreat. Further deglaciation resulted in the formation of outwash deposits in the Indian Brook Valley. A poorly defined terrace approximately 2 m above current lake levels indicates that the outlet of Mic Mac Lake was at a higher altitude in the past. The current outlet has cut a rocky gorge, and it is likely that down-cutting occurred postglacially. Tucker (1974) reported marine terraces below marine limit at altitudes of 66, 60, 54, 15 and 9 m in the Springdale area. Similar features are recognized near King's Point, Middle Arm and Rattling Brook, although only the 15-m terrace is clear. These indicate stillstands in isostatic rebound, but are undated, so construction of a sea-level curve is not possible. The comments of Macpherson (in Blake, 1987) suggest that vegetation was established in the area by 10,000 BP, and most bogs and fens developed through the Holocene.

IMPLICATIONS FOR DRIFT EXPLORATION

The ice-flow history suggests that sediment dispersal should be dominated by the later eastward flow. It is possible that reworking of till deposited by the earlier northward ice movement, and forming north-trending dispersal trains, might result in widening of such dispersal patterns. Diamicton deposited as basal melt-out till should represent an ideal sampling medium for tracing of dispersal. In washed areas, dispersal of fines is probably related to current flow, and paleocurrent indicators should be useful in determining direction of transport. In these areas, coarse clasts are mainly dispersed by ice, and ice-flow data can be used in boulder tracing. Careful examination of surficial sediment is required to distinguish diamicton from ice contact gravels, which would show dispersal patterns unrelated to ice flow. Geochemical results from sampling of coastal areas below 75 m a.s.l. must be considered dubious, due to reworking by marine processes. Similar caution should be exercised in the vicinity of Mic Mac Lake, where lacustrine proccesses have reworked surficial sediment.

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