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QUATERNARY GEOLOGY OF THE BAIE VERTE PENINSULA

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ABSTRACT

Ice flow over the Baie Verte Peninsula was determined by the mapping of ice striations and oriented landforms, and evidence for at least two phases of ice flow were found. The earlier phase consisted of a north to northeast flow over the southern part of the peninsula, diverging east and west over the centre of the peninsula, which acted as an ice divide. The later flow was controlled by local topography, in which the local ice acted independently of the main central Newfoundland ice cap. In the Rambler area, early flow was to the northeast, but later flow shows evidence of an ice divide, with flow both north and south. In an area where striations indicate divergent flow directions, clast fabric analysis was successful in identifying the direction of flow that deposited the surface sediment. Vertical sections in the Indian Brook Valley, suggest the presence of ice-dammed lakes at two separate levels during deglaciation and relict ice wedges indicate periglacial conditions following deglaciation of the valley.

INTRODUCTION

The Baie Verte Peninsula (Figure 1), located in north-central Newfoundland, is of considerable interest with regard to mineral exploration. It has been the site of mines since 1864, having active mining for copper, silver and gold up to 1982 (Hibbard, 1983). In 1988, numerous exploration crews from different mining companies were active on the peninsula, prospecting for gold. Exploration techniques employed by these companies included soil sampling and boulder tracing. The interpretation of results obtained by these methods requires a prerequisite understanding of the ice-flow history, and genesis of surficial sediment. The results of this initial study better define the Quaternary geology of the area, which should help to improve the efficiency and effectiveness of drift exploration on the Baie Verte Peninsula.

Location of the Study Area

The study area is the same as that of Hibbard (1983), bounded by the Trans-Canada Highway to the south, Green Bay to the east, and White Bay to the west (Figure 2). This encompasses all of four 1:50,000 map sheets (2 E/14, 12 H/16, 12 I/1, and 2 L/4) and parts of seven others (2 E/5, 2 E/12, 12 H/7, 12 H/8, 12 H/9, 12 H/10, and 12 H/15).

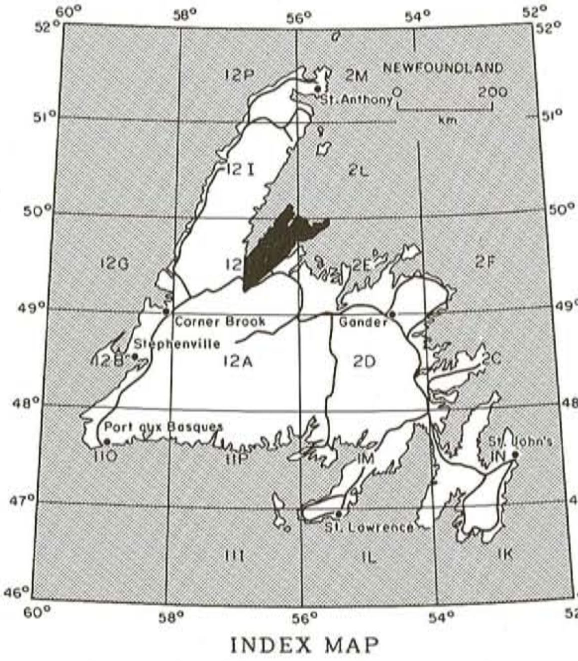

Figure 1. *Index map of the study area.*

Bedrock Geology

A comprehensive summary of the bedrock geology is provided by Hibbard (1983). The Baie Verte Peninsula exposes rocks of both the Dunnage and Humber zones, separated by a sharp structural lineament, the Baie Verte line (Williams, 1978). West of the Baie Verte Line are found rocks of the Fleur de Lys belt. These consist of deformed schists and gneisses, intruded by granitoids, and form the eastern margin of the Humber Zone (Hibbard, 1983). Rocks of the Dunnage Zone are found east of the line and consist of ophiolite suites, volcanic cover sequences, and various intrusive rocks, known as the Baie Verte belt (Hibbard, 1983). All the mines and most major showings of economic minerals are associated with the ophiolitic rocks of the Point Rousse and Advocate complexes, and the Paquet Harbour group within the Baie Verte belt, although significant mineralization has been located in the Fleur de Lys belt.

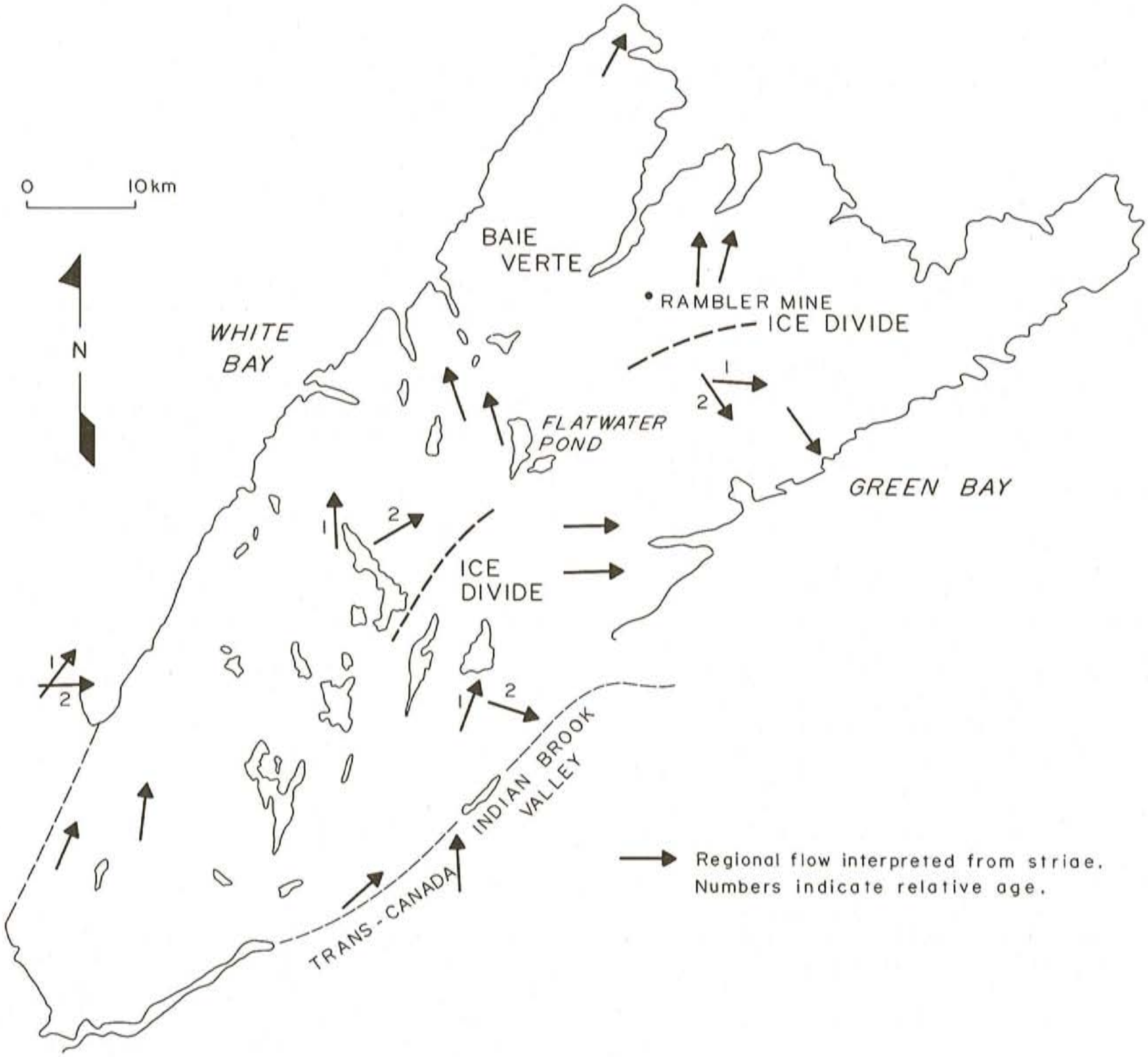

Figure 2. *Ice-flow patterns over the Baie Verte Peninsula. Arrows represent regional flows interpreted from the striation sites.*

Previous Work

Lundqvist (1965) examined ice striations in the area and suggested that there is clear evidence for a single, Late Wisconsinan, major ice flow from the southwest to the northeast over the peninsula. During deglaciation, local topography became increasingly important and caused considerable local variation in flow direction. Tucker (1973, 1974) worked south of the field area, as did Alley and Slatt (1975), and ice striations and oriented-landforms indicate a similar ice-flow history to that determined by Lundqvist (1965).

Grant (1974) suggested that the Baie Verte Peninsula may have supported an independent ice cap during the final stages of Late Wisconsinan deglaciation, with radial flow from the centre of the peninsula. Grant (1986) mapped the peninsula on a reconnaissance level at a scale of 1:50,000, based mainly on aerial photograph interpretation, but with some ground verification.

Vanderveer and Taylor (1987) mapped the Hampden–Sops Arm region on the western margin of the study area, and recognized two regional ice flows; an early west to east flow from ice centred on the Long Range Mountains, followed by a later southwest to northeast flow. Hibbard (1983) provided a map of glacial features, summarized from previous work.

Ice Flow

Figure 2 shows regional ice flows interpreted from over 170 ice-striation sites, including 25 sites from other work

(Lundqvist, 1965; Grant, 1986; Vanderveer and Taylor, 1987), and aerial photographic interpretation of oriented landforms (flutings, drumlins, and crag and tail features), which are not common in the area. Prominent lineaments on aerial photographs commonly parallel bedrock trends rather than reflecting glacial flow. In general, the modern topography appears to be largely bedrock controlled rather than by glaciation.

Ice striations are small-scale erosional features that are formed when clasts transported by ice are moved over bedrock at the base of the ice, and scour the bedrock surface; this results in linear features on a variety of scales. Striations are excellent indicators of ice flow as they are formed by the direct action of moving ice. However, the information from ice striations sites should be treated with caution because of the following reasons:

1) A striation only reflects ice flow at the time of its formation, and should not be used to indicate the total ice-flow history of an area. Earlier or later flows do not necessarily parallel the ice flow recorded by the striation.

2) Striations are relatively small-scale features, and only indicate local flow conditions. Regional ice-flow patterns can show considerable local variation, with ice being deflected by topography and resistant bedrock. Thus regional flow can only be deduced after examining sufficient striation sites to show a regional pattern.

3) The orientation of ice flow can be easily discerned from striations by measuring the azimuth of the linear features. Ice-flow directions can be determined by observation of the striation pattern over the outcrop, where areas in the lee of ice flow may not be striated; by the presence of such features as 'nail-head' striations, and miniature crag and tails; and by the morphology of the bedrock surface, which may show the effects of sculpturing by ice. In many sites, the direction of ice flow is unclear, and only the orientation of ice flow can be deduced.

4) Striations produced by earlier flows can be eroded or obscured by striations produced by later events.

Thus the regional flows interpreted on Figure 2 are all based on at least five striation sites. Where possible, relative age relationships have been interpreted for sites showing more than one striation orientation. These relationships are based on cross-cutting of striation sets, and preservation of older striations in the lee of younger striations. The age relationships plotted on Figure 2 are based on at least three sites.

Ice flow over the peninsula has been complex. The orientation of ice-flow indicators can be explained by postulating two phases of ice flow. The early phase consisted of a north to northeast flow from the central Newfoundland ice cap over the southern part of the peninsula. The centre of the area shows divergence, having eastward flow to the east of the peninsula, and a west to northwestward flow, to the west. This suggests that an ice divide existed in the central part of the peninsula. The later phase consisted of flow controlled by local topography, where local ice acted independently of the central Newfoundland ice cap. In the Rambler area, early-phase flow was to the northeast, but ice flow of the later phase shows an ice divide, with flow to both north and south. During the later phase, ice flowed northeastward along the Birchy Lake–Indian Brook valley. This suggests that ice on the Baie Verte Peninsula was separated from central Newfoundland ice, and may have been flowing south into the valley.

The preliminary interpretations are tentative, as relatively few flow indicators have been located for the size of the study area. Future field work planned for 1989 will check and refine this interpretation.

Relationships Between Ice-Flow Indicators

In mineral exploration, surficial sediment is sampled and analyzed geochemically. Such analyses aim to define geochemical anomalies, related to presence of mineralized bedrock in the area. In glaciated areas, bedrock has been eroded and transported by ice and deposited as surficial sediment. The sediment commonly resulting from deposition in the glacial sedimentary environment is diamicton. Diamicton is a non-genetic term for any poorly sorted sediment showing a range in grain size from clay to gravel, whereas the more familiar term till is restricted to diamictons deposited directly by the action of glacial ice. Thus knowledge of direction of local ice flow is required in locating the source of anomalies.

Striations are oriented parallel to ice flow, but in the case of multiple striation directions, it is not always possible to relate the ice flow deduced from striations to that which moved the sediment being sampled. In glacigenic diamictons, orientation of clasts is often used to infer ice flow, with the clast-long axis oriented parallel to flow (Holmes, 1941; Harrison, 1957). The advantage of this method, known as clast fabric analysis, is that the flow direction obtained moved the sediment being sampled. Clast fabric is also useful in determining diamicton genesis, with strong unimodal fabrics being typical of basal melt-out and lodgment tills, and less well oriented fabrics being found in supraglacial melt-out tills, debris flows, and diamictons produced by ice-rafting of clasts (Lawson, 1979; Domack and Lawson, 1985; Shaw, 1987).

To investigate the usefulness of clast fabric analysis in the Baie Verte area, and the relationship between ice flow, as deduced from clast fabric analysis, and striations, thirteen fabrics were measured from diamicton exposed in trenches in the Flatwater Pond area (Figures 3 and 4). Two striation sites in the vicinity are interpreted as showing an early flow to between 325 and 350°, followed by two subsequent flows at 310 to 320 and 290° (Figure 3). Four other sites show

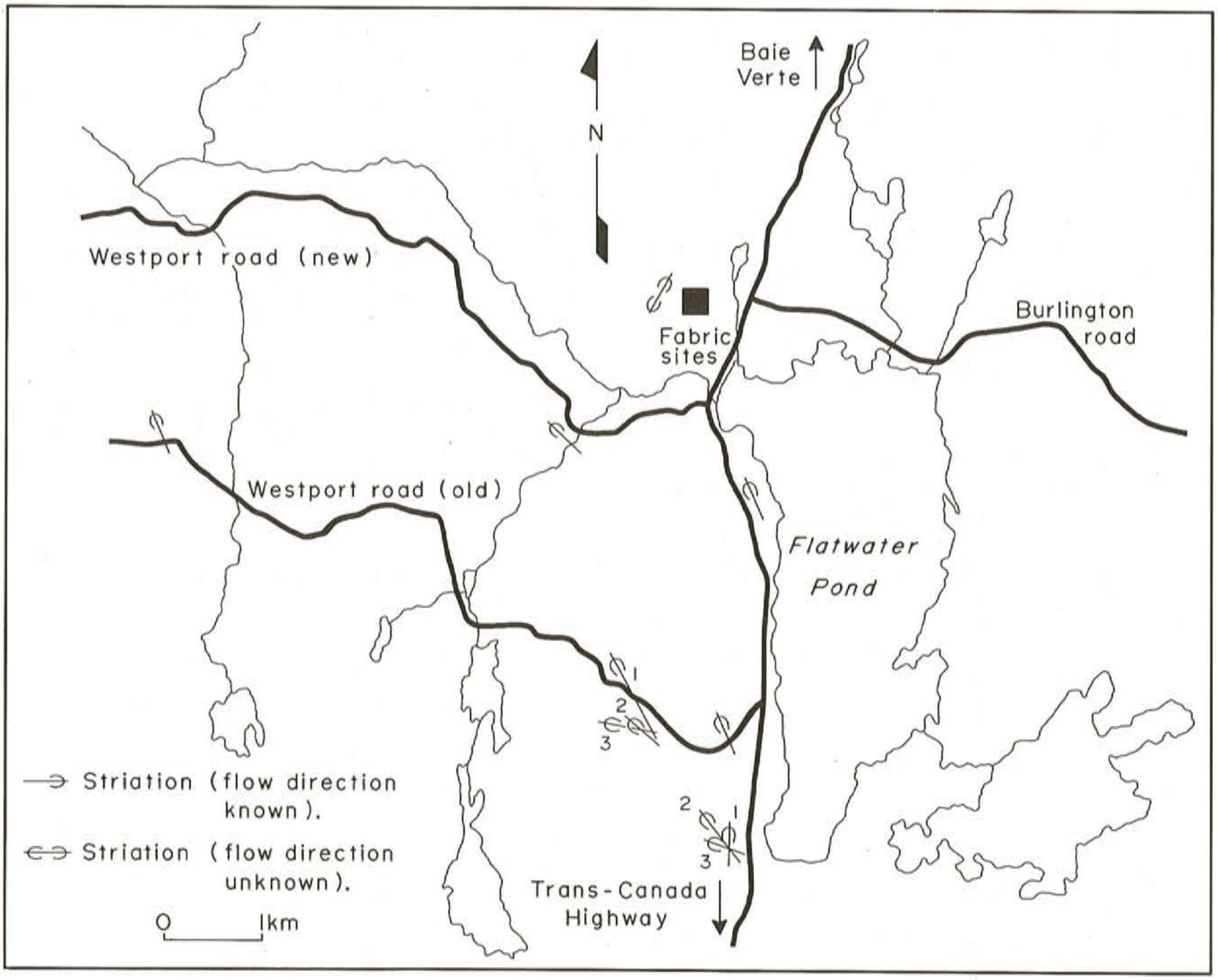

Figure 3. *Striation sites in the vicinity of Flatwater Pond, and location of fabric sites. Numbers indicate age relationships of a set of striation; 3 the oldest, 1 the earliest.*

single sets of striations, oriented between 340 and 350°. A single site in the trenches shows indistinct striations oriented at 037°.

Diamicton exposed in trenches is mainly massive, with a sub-horizontal fissility. Clasts are mainly angular, are of local provenance and constitute between 60 and 80 percent of the diamicton, whereas the sandy matrix forms between 20 to 40 percent. Fragile clasts are 'smeared' along horizontal planes and clasts rarely are aligned along distinct sub-horizontal lines. Resistant clasts are frequently striated. The thickness of the diamicton is variable and controlled by bedrock topography; in lows, diamicton is up to 2.5-m thick, but thins to less than 1 m over bedrock highs.

The results of fabric measurements are variable. Seven sites show strong to very strong unimodal fabrics (S_1 values between 0.72 and 0.92; sites 88-26, 88-28B, 88-28C, 88-28D, 88-61, 88-63B, 88-65; Figure 4). Such fabrics are considered to be typical of basal tills (Lawson, 1979; Dowdeswell and Sharp, 1986; Shaw, 1987). The absence of sorted strata or lenses, dominance of local provenance material, presence of fissility and 'smeared' clasts, suggest that the diamicton is a lodgment till (Muller, 1983; Dowdeswell and Sharp, 1986). Six of these seven sites show a mean orientation suggesting ice flow to between 320 and 356°. Of the sites showing a less strongly oriented fabric, three (88-28A, 88-60, 88-64; Figure 4) show mean orientations between 322 and 002°. Thus it is likely that the dominant sediment-moving ice flow was approximately 330°. This matches the dominant striation direction observed in the surrounding area, and the earliest flow in multiple striation sites.

As deduced from ice-striations, the flow direction suggested is the earliest in the area, and it is possible that the variability in fabrics is due to the re-orientation of clasts by subsequent flow. This would have produced less well oriented fabrics, with a secondary mode to the west of the

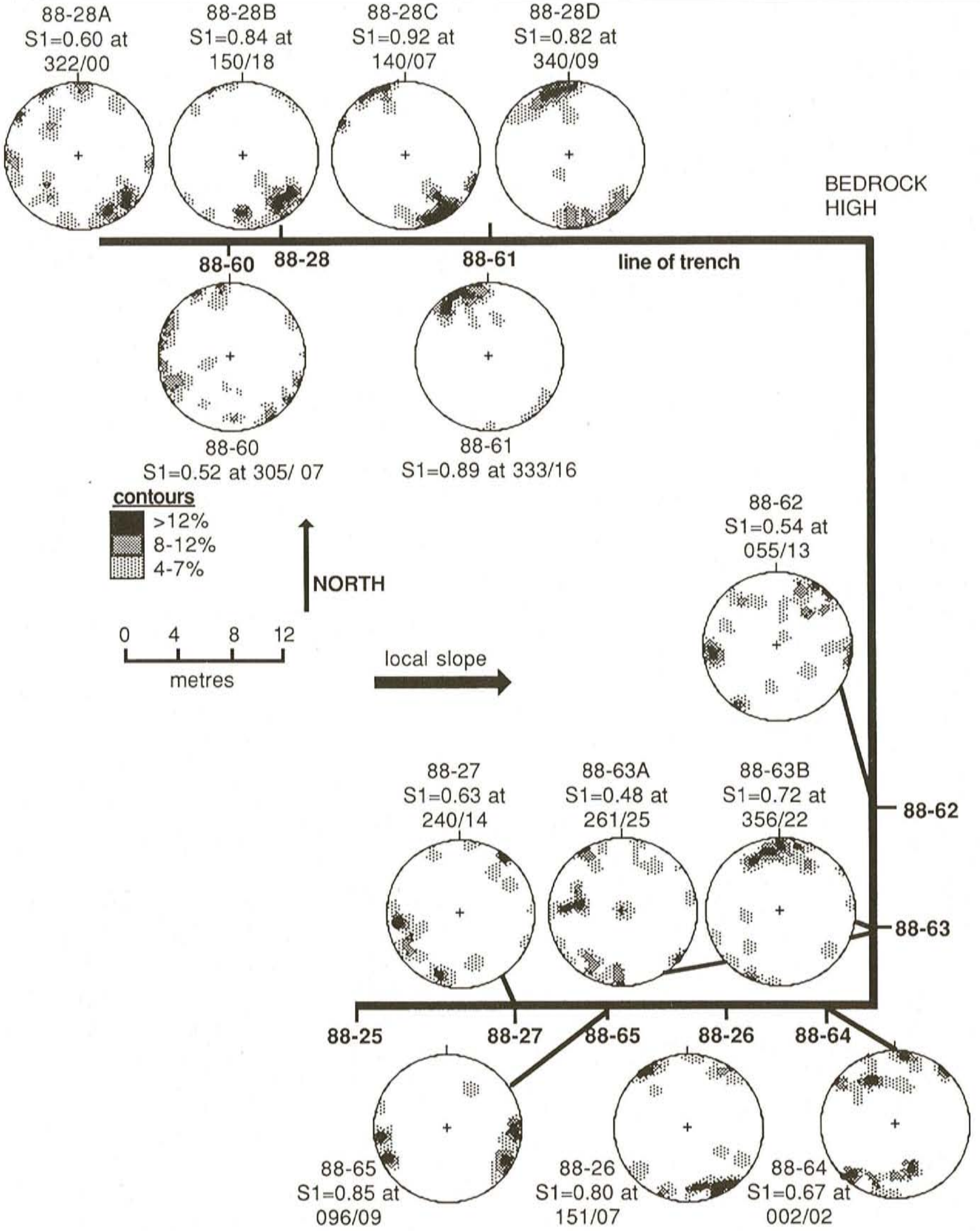

Figure 4. *Clast fabrics, Flatwater Pond trenches. The circular plots are equal area stereographic projections of orientations of 25 clast-long axes. They have been contoured using a 2 percent counting circle. The value of S_1 (the principal eigenvalue divided by the sample size) is followed by the azimuth and dip of the mean clast orientation.*

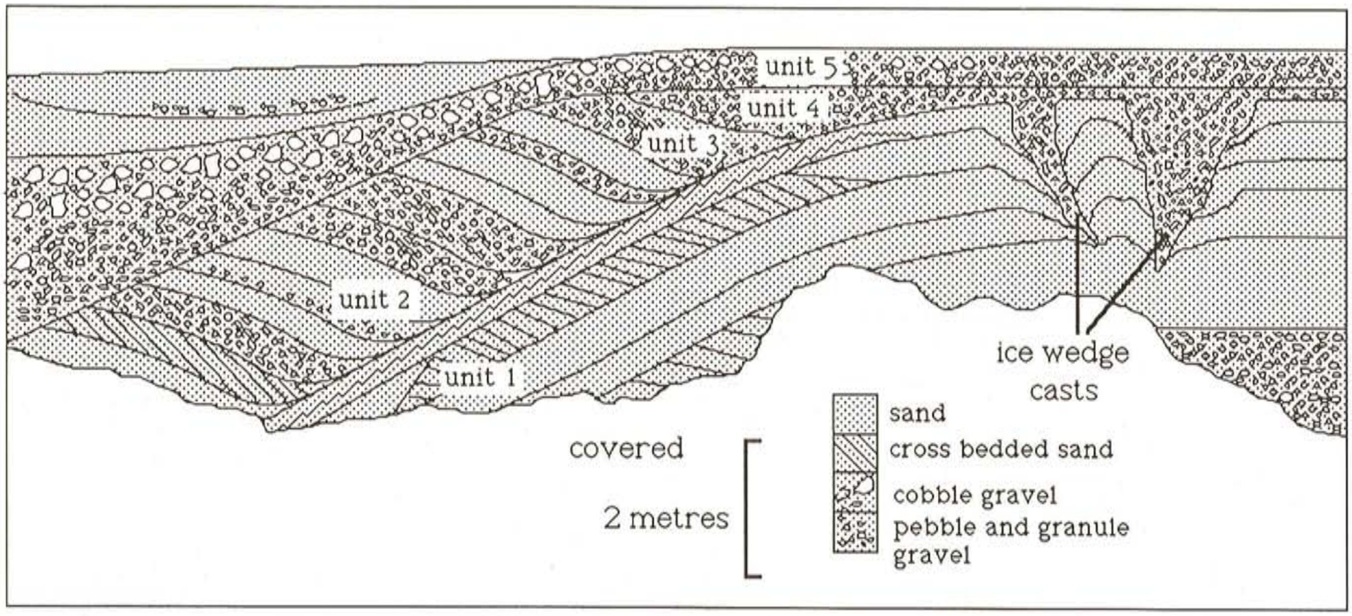

Figure 5. *Sketch of sections in gravel pit at Baie Verte Junction. Unit numbers refer to text.*

primary mode. Dowdeswell and Sharp (1986) found less well oriented fabrics in the upper of two layers in typical lodgment tills. In the cases where two fabrics were taken at different vertical positions at the same site (88-28 and 88-63; Figure 4), the strongest orientations were found at the higher site. Thus it is unlikely that the diversity found is due to either primary depositional processes or re-orientation by later ice flow. Therefore, it is suggested that the main cause of the diversity is post-depositional mass movement. Relief on the bedrock surface is considerable (30 to 40 m), and slopes are steep (up to 20°) and generally dipping to the east. Hence, mass movement of saturated sediment would be likely. The vertical variation in fabric strength and orientation would be due to a series of minor mass movements taking place as cohesive debris flows, with most movement taking place along a zone of dislocation at the base of the sediment. Thus, the upper parts of the diamicton would be rafted relatively undisturbed, but clasts at the base would be re-oriented. Sites 88-27, 88-28A, 88-60, 88-62, and 88-63A (Figure 4) have relatively weak girdle fabrics, which are thought to be typical of debris flows (Nardin *et al.*, 1979; Lawson, 1981).

Evidence from this site suggests that a single fabric measurement may be misleading but multiple fabric measurements are useful in determining sediment-moving ice flow in an area, which had a complex ice-flow history.

Sections in the Indian Brook Valley

The southern boundary of the study area is the valley of Indian Brook (flowing to the northeast), and the Birchy Lake–Sandy Lake system (draining to the west). The drainage divide between the two systems lies at about 140 m above sea level. The valley contains several excellent exposures of Quaternary sediment, and preliminary examination suggests that they may be important in reconstructing the Quaternary history of the Baie Verte area. Two of these sections are discussed in detail.

Baie Verte Junction Gravel Pit. This section is located in a gravel pit lying west of the Baie Verte Highway in the vicinity of the intersection with the Trans-Canada Highway. Between 5 and 8 m of sand and gravel are exposed over 40 to 60 m laterally, forming a cut through the centre of a topographic high (Figure 5). Unit 1, (Figure 5) exposed at the southern end of the pit, consists of 1.5 m of interbedded fine to coarse sand, dipping at 35 to 50° (Figure 5, Plate 1). To the west, the dip decreases over 5 m to close to horizontal. The unit is cut by several small normal faults, which have displacements of 0.5 to 3.0 cm, the fault planes dipping at high angles, and striking approximately north–south. The sediments are mainly either flat stratified, or show planar tabular cross-beds. The cross-beds indicate current flow to the west (in the opposite direction to the primary dip of the beds). This interpretation of current flow is supported by observations of cross-lamination and climbing ripples in fine sand interbeds. Lamination is rarely contorted and folded into tight Z-folds. Sands throughout are moderately to well sorted, and beds are laterally continuous over at least 10 m.

Unit 2 (Figure 5) consists of 2 m of interbedded coarse sand and granule gravel. The beds dip at 5 to 10° to the west, with the dip shallowing up-section. The basal contact of this unit is sharp, truncates underlying beds of Unit 1, and dips to the east at 20°. The relationship of beds with the basal contact is both angular and asymptotic (Plate 1). The unit consists of 80 percent coarse sand and 20 percent gravel, both of which are well sorted. The beds are 10- to 15-cm thick. Gravel is clast supported and the average clast diameter is between 1 and 2 cm, and a maximum of 5 cm. Most beds are massive with some flat bedding and lamination. Planar tabular cross-stratification occurs in one bed. The top of Unit

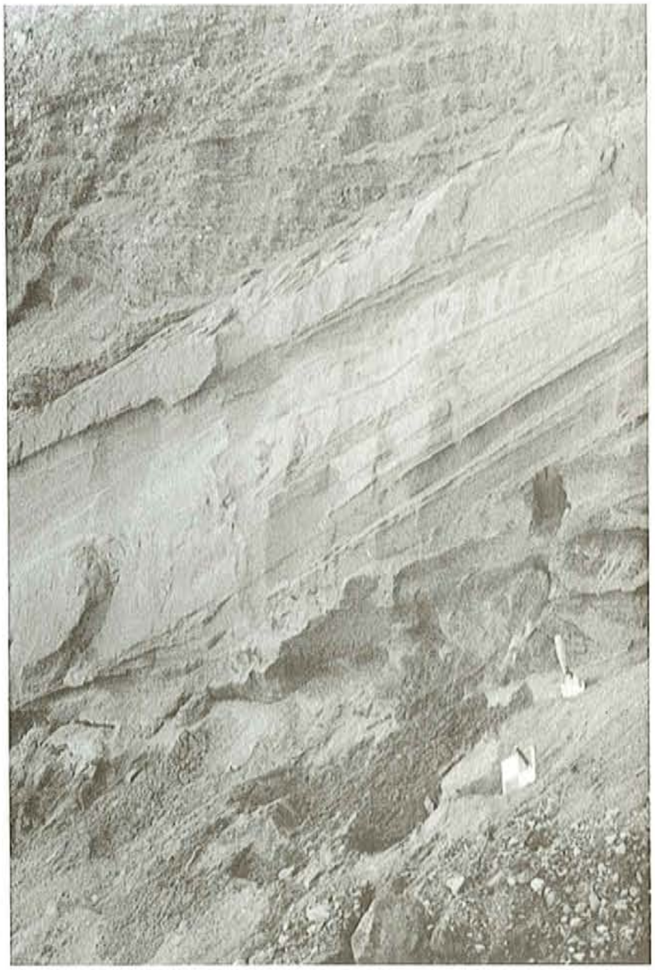

Plate 1. *South end of sections in Baie Verte junction gravel pit, showing contact between Units 1 and 2; interpreted current flow is to the right.*

2 shows 0.5 m of sand and gravel dipping at a low angle to the northeast. It is overlain by Unit 3 (Figure 5), a 1-m, inversely graded bed of gravel. The base of the unit shows mainly granule-sized clasts, which coarsen upward to cobbles. The gravel is generally poorly to moderately sorted, clast supported, and has a matrix of medium to coarse sand. The largest clasts are about 40 cm long. Unit 3 dips at 10 to 20° to the northeast. It is overlain by Unit 4, consisting of 2 m of interbedded fine to coarse sand and granule gravel, dominated by well-sorted sand. Unit 4 is flat-bedded and cross-bedded having prominent trough and planar tabular cross-beds, suggesting current flow to the west. The upper contact is marked by wedge structures (Figure 5), that penetrate and deform the underlying sand to a depth of at least 1.5 m. On the margins of the wedges, sand beds dip at high angles paralleling the wedge side, and are contorted. Three major wedge structures are seen in this exposure, with the top of wedges being up to 2 m across. The wedges are filled by massive pebble gravels. Many clasts within the wedges are oriented with long axes close to vertical. The gravel of the overlying Unit 5 is moderately sorted, clast supported, and 0.5- to 1.0-m thick, and marks the top of the section.

Interpretation. Examination of the sedimentary structures indicates that the sequence has undergone disturbance. The presence of well-formed, planar tabular cross-beds suggests that the primary bedding surfaces of Unit 1 were originally horizontal. Tracing these beds laterally to the west shows that the dip decreases to near horizontal over 5 to 10 m. The asymptotic contact between Units 1 and 2 suggests that it also was horizontal at the time of sediment deposition. Thus, the overlying beds of Unit 2, originally dipped at steeper angles to the west and may have been deposited as delta foresets. Unit 1 may therefore represent bottomset deltaic deposition, and units 3 and 4, topset beds and fluvial sediments. Deltaic deposition is supported by the well-sorted nature of the basal sediments, with grain-size changes suggesting considerable variation in discharge. Such an interpretation is also supported by the general coarsening-upward trend in the section.

The origin of post-depositional deformation is probably due to the melting of ice buried by the sediment. This style of deformation is unusual, in that the sediment appears to have deformed in a ductile rather than a brittle manner. Dry sand and gravel tend to respond to stresses by failing as coherent blocks, associated with numerous small displacement faults. In this case, only a few minor faults occur, and the displacement on these cannot account for the amount of subsidence seen. It is possible that this plastic-like deformation resulted from the sediment being saturated or frozen.

The wedge structures are interpreted as ice-wedge casts (e.g., Washburn, 1973). Such structures are formed when ice-wedges, formed under permafrost conditions, melt and are infilled by overlying sediment or collapse of the margins. All ice-wedges appear to have formed at the same stratigraphic level, indicating a period of non-deposition, and subaerial exposure ice wedges can form when the mean annual soil temperature is below -5 to -6°C, and there is an adequate supply of moisture (Péwé, 1966). Eyles (1977) reported similar structures in the Botwood area, east of this site.

Thus, this section has a complex depositional history, with indications of variable climate. Current-flow directions throughout the section are to the west, in the opposite direction to the slope and drainage of the present valley. The present altitude of the section is 50 m below the watershed that separates western from eastern flow in the valley. If easterly drainage was dammed by ice, local slope would be toward such an ice dam, and thus water would be impounded, forming a lake, and sediments would have been deposited in a prograding delta. Following drainage of the lake, or synchronous with its existence, ice buried by the sediments melted, which resulted in the collapse and deformation of the overlying material. A period of subaerial exposure followed, allowing the development of ice-wedges. Further sedimentation, probably in a fluvial environment, resulted in the burial and melting of the wedges, and the formation of ice-wedge casts.

Modern permafrost is not recognized in Newfoundland, and Eyles (1977) suggests that ice-wedge formation indicates mean annual air temperatures at least 10°C below modern values. Evidence at the Baie Verte Junction section suggests an initial warm period resulting in deglaciation and formation of an ice-dammed lake, followed by cooling, and a considerable time with lower temperatures to allow the formation of large ice-wedges. Eyles (1977) estimates ice-wedges of similar size would require approximately 2000 years to form. Subsequent burial resulted in the degradation of ice-wedges, and lack of development of periglacial features in upper units of the sequence suggests a warming of climate. No direct chronological control is available for these events. In the Springdale area, there is an extensive complex of raised marine deltas (Tucker, 1973, 1974). Shells from these deltas have provided radiocarbon dates in the range 11,000 to 12,000 BP (Dyck and Fyles, 1963; Lowdon and Blake, 1975; Blake, 1988). Basal lake dates on the peninsula range from 11,800 to 10,400 BP (Blake, 1986, 1987, 1988). It is likely that these marine deltas were deposited, synchronous with or, subsequent to deposition of the sequence described above. It is tentatively suggested that the cold period, resulting in formation of ice-wedges, lay between initial deglaciation of the Indian Brook valley, and the final disappearance of ice from the region.

Upper Indian Brook Sections

In upper Indian Brook, sections extending 300 m laterally, are exposed along a new logging road at approximately 175 m above sea level (Figure 2). Four small sections that represent the entire exposed sequence were chosen for detailed description (Figure 6).

Section 88-81A (Figure 6) contains 2 m of interbedded sand and gravel, dipping at low angles to the south. Gravel constitutes 10 to 15 percent of the section, and is clast supported, granule sized, well sorted, and has a coarse sand matrix. Sand varies from fine to medium grained, associated with a single bed of fine sand to silt. The dominant sedimentary structure is planar bedding, which has some planar tabular cross-stratification that indicates current flow to the south. The fine sand—silt bed is planar laminated at the base, but grades upward to cross-laminated sand. The upper part of this sequence is contorted and folded. The section is capped by 1 m of flat-bedded, clast-supported, pebble gravel. This section is interpreted as showing small-scale delta foresets, with the source of sediment and water to the north of the section.

Section 88-81B (Figure 6) is 4-m thick, with the base lying 1 m above the top of section A and 20 m north of it. The base of the section consists of 1.9 m of interbedded sand and silt and minor gravel. Two units, toward the base, consist of rhythmically laminated fine sand and silt. Each lamina consists of a sharp basal contact, grading normally from fine sand to silt. Laminae are folded and contorted into wide and tight folds. Rare pebbles disrupt the lamination. Overlying these units is 1 m of laminated diamicton. The matrix consists of fine sand and minor clay and silt that constitutes 70 percent of the diamicton. Clasts range from granules to cobbles and deform the lamination underlying them. This sequence is interpreted as showing a transition upward from lacustrine deposition close to a source of sediment at the base, to more distal lacustrine deposition, with input of coarse material by ice-rafting. The sections are exposed on a hillside, and the only possible method of forming a lake in this topographic setting is by damming of drainage by ice.

Section 88-81C (Figure 6) consists of 8 m of diamicton and poorly sorted gravel. The lower part of the sequence consists of diamicton and abundant sorted beds and fine sand to granule gravel laminae (Plate 2). Clast content is 30 percent at the base but increases upward to between 40 and 50 percent. The matrix is mostly sand and some fines, and in places is weakly horizontally laminated. Two fabrics from the basal units show weak to moderate girdle distributions (Figure 6). The genesis of such diamictons is hard to determine, but the weak fabrics combined with the low clast content and abundant sorted strata suggest subaqueous deposition in the proximity of glacial ice. Deposition may have taken place by debris flow, or a combination of suspension settling and ice-rafting. The overlying unit, consisting of a poorly sorted matrix-supported gravel, is very similar to the underlying sediment, but contains few fines. Clasts are mainly pebbles, but cobbles are common, and a few boulders occur.

Plate 2. *Structures in diamicton, base of section 88-81C; sorted lense indicates current activity during deposition of the sediment.*

Section 88-81D (Figure 6) consists largely of clast-supported, poorly sorted gravel and interbeds of well-sorted fine to coarse sands (Plate 3). The gravel is massive or crudely stratified and contains striated and faceted clasts of mainly pebble size. Some cobbles and boulders are present. The matrix is a fine to coarse sand associated with rare, well-sorted laminae of fine to medium sand. Interbeds of sand are well sorted, and are mainly massive or planar stratified.

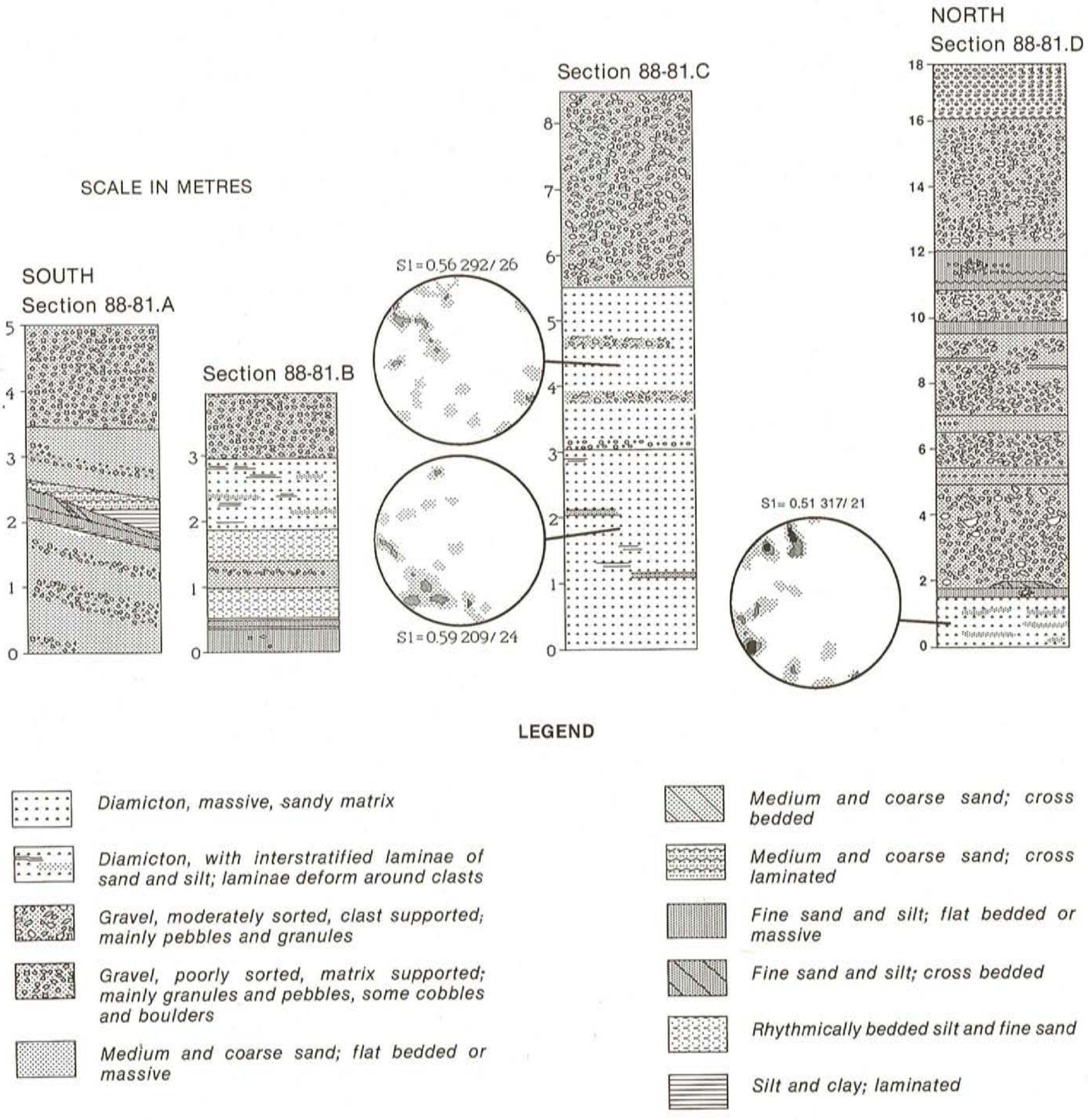

Figure 6. *Stratigraphic columns (sections 88-81A to 88-81D) exposed in the Upper Indian Brook area.*

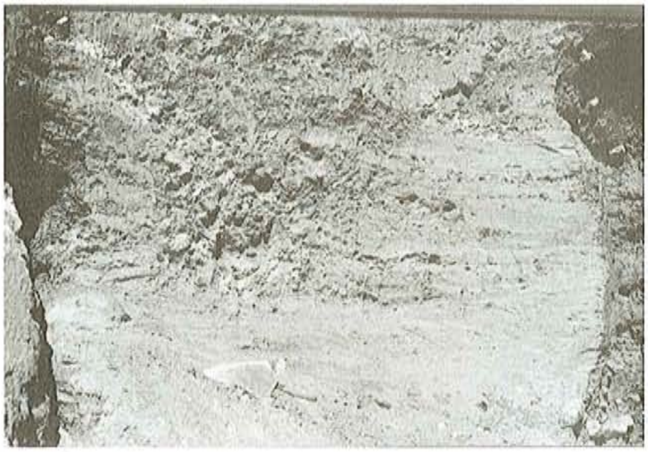

Plate 3. *Laminated sand and silt in section 88-81D; poorly sorted gravel is probably ice-rafted and either dumped or formed when ice grounded, and melted in place.*

Toward the top of the section, a thick sand interbed is cross-laminated, indicating current flow to the west. The section is capped by 2 m of moderate, to well-sorted, matrix-supported gravel.

Matrix-supported, poorly sorted gravel is probably formed either by mass movement, or by ice-rafting and rain-out of clasts into an environment where current action winnows fines from the substrate (Nardin *et al.*, 1979; Eyles and Miall, 1984). In this case, probably both processes were operating, with the sand interbeds indicating a moderate energy, possibly pro-delta, environment.

In summary, the sections in upper Indian Brook valley contain relatively thick sequences that might be interpreted as till in poor exposures. The sedimentary characteristics of the diamictons in association with probable deltaic and lacustrine sand and silt suggest that the sequence represents deposition into a glacial lake. The diamictons and poorly sorted, matrix-supported gravel units were probably deposited by a combination of mass movement and ice-rafting. This implies that ice was adjacent to, or moving into, the lake.

The elevation of the sections is between 160 and 180 m (estimated from topographic maps). It is possible that the lake was an ice marginal feature, formed when ice filled the Indian Brook valley and dammed southern drainage from the Baie Verte Peninsula. Such a lake would be a minor feature. Alternatively, the lake thought to exist here may be related to the lake postulated from evidence at the Baie Verte Junction section. If so, the lake was large and may have been connected to the Sandy Lake—Deer Lake basin, to the west. To produce thick diamicton sequences in this setting, ice may have been moving south from the Baie Verte Peninsula into an ice-dammed lake in the Indian Brook valley.

Implications for Drift Exploration

The preliminary ice-flow history described here is very complex having considerable local variation. Any attempt to relate anomalies in surficial sediment to bedrock sources should take this into consideration. In problematic areas, careful mapping of ice striations may assist in defining ice-flow history. Clast fabric analysis may be useful in defining sediment moving ice flow in areas of complex or divergent flow, but multiple measurements are recommended. Drift sampling in areas adjacent to the Indian Brook valley may encounter thick sequences of diamicton, deposited subaqueously. Geochemical results from such sediment may be misleading or difficult to interpret, as transport and deposition in ice-proximal glaciolacustrine sequences tend to be very complex.

CONCLUSIONS

The major results of 1988 field work are:

1) The ice-flow history for the Baie Verte Peninsula is complex, with at least two major phases of flow, and with considerable diversity of flow direction;

2) ice divides existed in the Flatwater Pond region, and in the area of Gull Pond (south of the La Scie road);

3) the striation database is small considering the size of the study area and in planning and interpreting the results of geochemical data, consideration should be given to examination of local flow patterns by more detailed mapping;

4) clast fabric analysis may be a valuable supplement to striation and landform mapping in areas of complex ice flow; such work is only useful if the sedimentology and genesis of the till being sampled is well understood;

5) sections in the Indian Brook valley suggest a complex history of deglaciation with evidence for glacial lakes existing at two elevations; and

6) observations of relict ice-wedges confirm the earlier conclusion of Eyles (1977) that severe periglacial climatic conditions followed deglaciation in north-central Newfoundland.

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