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SURFICIAL GEOLOGY OF THE CAVERS AND HOLLINGER LAKE AREAS (NTS 23J/9 AND 16), LABRADOR

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ABSTRACT

Mapping of the Quaternary geology of the Cavers Lake and Hollinger Lake map areas has shown that the region was affected by two major ice-flow events; an early southeast to south flow, and a later northeast to east-northeast flow. The southeast flow was parallel to bedrock strike and has had a major effect on the geomorphology of the area, sculpting bedrock surfaces, but leaving only a fragmentary striation record. Most polished bedrock surfaces are covered by striae relating to the later northeasterly flow. Clast fabrics and the pattern of dispersal of clasts from outcropping gabbro and iron formation indicate that the later northeastern flow was the dominant agent of dispersal of surface diamictons.

Surficial geology is controlled by bedrock type and topography, with thicker sediment cover in topographic lows underlain by shale. Surface sediment is mostly diamicton, or bog, associated with minor glaciofluvial gravels. Close to Attikamagen and Petitsikapau lakes, the surface diamicton has been affected by higher lake levels, with silt and clay winnowed from the coarser fraction. Drainage was probably reversed following deglaciation, due to differential isostatic depression, and higher lake levels were possibly caused by damming of the northward drainage by the retreating ice sheet.

These results will be useful in mineral exploration in the area, by identifying the dominant dispersal direction of surface sediment, and appropriate sampling media.

INTRODUCTION

The Labrador Trough extends from Labrador City into northern Quebec, and has been the site of mining and exploration for over forty years. In recent years, the central Labrador Trough has seen little activity. Work by the Geological Survey Branch has suggested that this area shows high potential for PGE and sediment-hosted massive sulphide mineralization (McConnell, 1984; Wardle, 1987; Swinden *et al.*, 1991; Swinden, 1991; Swinden and Santaguida, *this volume*). Much of the area has a thick Quaternary sediment cover with poor bedrock exposure. Exploration will thus have to incorporate drift-prospecting methods into their activities, and an understanding of the Quaternary history will be important in interpreting results. This is the second field season of a project designed to provide 1:50 000 Quaternary mapping in this part of Labrador. The 1991 field season concentrated on mapping the western side of the Trough (the Newfoundland parts of the NTS map areas 23J/10 and 23J/15), with an emphasis on ice-flow history, and stratigraphy (Liverman and Vatcher, 1992). This paper reports preliminary results on a detailed sampling and mapping program over the eastern part of the Labrador Trough, covering the NTS map areas 23J/9 (Cavers Lake) and 23J/16 (Hollinger Lake) (Figure 1).

OBJECTIVES

The objectives of the project are:

1. to map the surficial sediment cover of the area, using aerial photographs and field checking; and to identify the grain size, thickness and genesis of the sediment;
2. to map ice-flow indicators (striations, landforms, and clast fabric) and investigate clast provenance in order to determine the ice-flow history of the area;
3. to examine and map the geomorphology of the area;
4. to integrate the information obtained to enable an interpretation of the Quaternary geological history for the area; and

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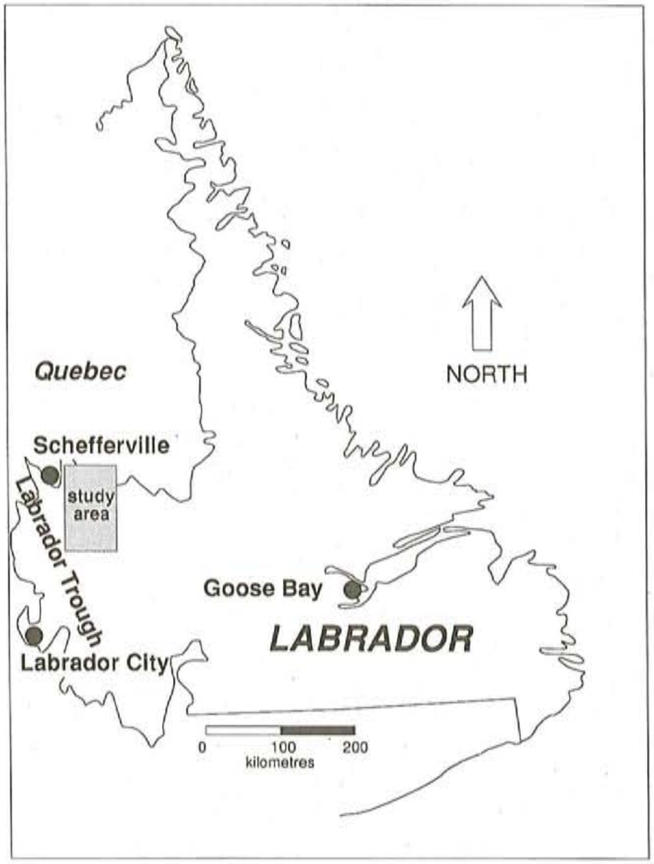

Figure 1. *Location of study area.*

5. to use the geological history in developing a model for sediment dispersal, of use to mineral-exploration companies using drift-exploration techniques.

LOCATION AND ACCESS

The study area is located 150 km north of Labrador City, and 20 km east of the town of Schefferville, Quebec (Figure 1). The Labrador–Quebec boundary crosses the northeast corner of the NTS map area 23J/16, but the rest of the study area lies within Labrador. Numerous large lakes provided boat or canoe access to close to half the study area. The rest of the area was reached by float plane and helicopter.

PHYSIOGRAPHY

The area is part of the Labrador lake plateau, a wide upland area with little relief and covered by many lakes. Topography is strongly controlled by bedrock, with most higher ground consisting of elongate northwest–southeast-oriented ridges, parallel to bedrock strike. Lake basins show the same elongate pattern. In the study area, Attikamagen, Petitsikapau, Dyke and Astray lakes form a major lake system that drains southward by way of the Ashuanapi River into the Smallwood Reservoir. Attikamagen and Petitsikapau lakes form wide, low-relief basins, with many islands. Greater relief is found at the western and eastern sides of these lakes, and on the margins of Dyke and Astray lakes.

PREVIOUS WORK

Low (1896) noted striations at the north end of Dyke Lake indicating southwestward ice flow. Harrison (1952) recognized three directions of flow in the Schefferville area, a southeastward flow that sculpted the main features of the landscape, followed by a flow to the northwest, and subsequently a flow to the northeast. Henderson (1959) also recognized an early dominant landforming southeasterly flow, with a later shift in flow to the east. Kirby (1960, 1961, 1966) reported till-fabric analyses in the Schefferville area that showed that the last ice movement in the area was oriented north-northwest–south-southeast. He also reported striations that indicated an early northeast flow followed by a later south-southeast flow, and suggested that the age relationship derived by Henderson (1959) was incorrect.

Klassen and Thompson (1987, 1989, *in press*) identified five phases of ice movement in the Schefferville area through mapping of erratics and striation evidence. Phase I consisted of flow westward from the Schefferville area. It was identified by dispersal of Trough erratics onto the Archean highlands, west of the study area. Phase II consisted of north to north-northeast flow, affecting mostly the area north and west of the present study area. Phase III consisted of flow both northwest and southeast from an ice centre located southeast of Attikamagen Lake, which migrated north of Schefferville. Phase IV consisted of strong eastward flow across the Archean Highlands into the Trough, affecting mainly the area south of Schefferville. Phase V was considered to be minor and short lived, and resulted in northeastward flow in the Schefferville area, which had little effect on outcrop morphology (supporting the results of Henderson, 1959). Klassen and Thompson (1987) suggested that a red porphyritic rhyolite outcropping east of Martin Lake provides a useful indicator erratic, and outlined a dispersal pattern that was interpreted as showing dispersal in all directions from the outcrop.

Liverman and Vatcher (1992) interpreted the striation record west of the study area as showing an early strong flow to the southeast, shown by large-scale oriented landforms and striae. A later flow was separated into two components, a northeast flow and an east-northeast flow, although the age relationship between them was not clear. Where well-oriented clast fabrics were found, they suggested northwest–southeast ice flow.

Liverman and Vatcher (1992) also suggested that the landscape west of the study area was dominantly one of erosion, rather than deposition, with the effects of meltwater erosion dominant, and glacial processes having little effect on the surface sediment cover.

Reconnaissance geochemical analysis of lake-sediment samples located two zinc anomalies in the area west of Martin Lake, and in an area northwest of Muskrat and Cunningham lakes (McConnell, 1984). Follow-up water- and stream-sediment surveys confirmed the presence of anomalous zinc, but were unable to locate a source due to extensive bog cover.

BEDROCK GEOLOGY

The geology of the area was first described by A.P. Low, who also identified the economic potential of the iron-ore deposits of the Labrador Trough (Low, 1896). Further detailed mapping was performed from the 1940's onward by the Iron Ore Company of Canada, the Newfoundland Department of Mines and Energy, and the Geological Survey of Canada. Wardle (1982) compiled existing information on the central Labrador Trough geology into a comprehensive map of the area. The study area is underlain by Aphebian sedimentary and volcanic supracrustal rocks of the Labrador Trough (Greene, 1974; Wardle 1978; Wardle and Bailey, 1981). These include iron formation, chert, quartzites, dolomite, sandstones, siltstones and shales of the Sokoman, Denault, Menihek, Fleming, LeFer, Wishart and Dolly formations; and gabbros and basalts of the Nimish Formation and Montagnais Intrusive Series (Evans, 1978; Wardle, 1982).

ECONOMIC GEOLOGY

Economic interest has been mainly in the iron ore exploited for 30 years in the Schefferville area. The eastern margin of the Labrador Trough hosts more than 50 pyrite and base-metal occurrences (Swinden, 1991). In the study area, notable showings occur in the Martin Lake area, containing copper, lead- and zinc-bearing massive sulphides; and at Katy Lake, which consists of massive pyrite (Swinden, 1991; Swinden and Santaguida, *this volume*).

FIELD METHODS

Very few natural sections exist in the study area, so field work mainly consisted of sampling from the base of hand-dug pits, up to 1.5 m deep. At each site, the surface sediment was described, and samples taken for later geochemical and textural analysis. Approximately 100 pebbles were collected at each site, and these were washed, cracked and identified. Five clast fabrics were obtained from three sections, using the methods outlined by Liverman (1992). Any striated outcrops were examined, and ice-flow indicators recorded. Two hundred and eighty samples were taken with the successful objective of covering the study area with a grid having a 2 to 4 km spacing between sites. A further 70 samples were taken as part of a detailed study in the area of Martin Lake with the objective of defining glacial dispersion from a massive sulphide showing.

RESULTS

ICE FLOW

Three lines of evidence were used to examine ice flow in the study area, striations, large-scale oriented landforms, and clast fabrics. Striations are small-scale erosional features, and provide a detailed record of the ice-flow history. Large-scale oriented landforms offer a less detailed picture, often being controlled by bedrock structure (cf. Liverman, 1992). Clast fabric uses evidence from deposited glacigenic sediment, and is useful in identifying the major sediment-dispersing ice flow in areas having a complex ice-flow history.

STRIATIONS

Approximately eighty striation sites were mapped, and many showed evidence of more than a single ice-flow direction (Figure 2). Care has to be exercised when examining bedrock outcrop on the margins of major lakes in the area. The action of wind on lake-ice results in major push effects on the lake shore (Pyökäri, 1981). Such shore-ice may freeze boulders to its base, and striate bedrock as it is thrust over the shoreline. Thus, striae sites at lake edges were examined critically, with the expectation that striations resulting from ice push would be shallower, broader, and less consistent both locally and regionally than glacial striae.

The results of striation mapping are summarized in Figure 2, and suggest that ice flow in the area had two major phases (Plate 1). The earlier ice-flow event consisted of a flow parallel to bedrock strike, and was to the southeast over most of the study area. This flow had a major effect on landforms, and resulted in many rôches moutonées, and other stossed and polished bedrock outcrops. The northwest margin of the map area has outcrops that show northwest–southeast-oriented striae, but are stossed, suggesting flow to the northwest. This pattern was confirmed by examining further outcrops north of the main study area. This may represent a separate ice-flow event, or indicate an ice divide in the area of Attikamagen Lake.

The later northeast to east-northeast ice-flow event is found throughout the area, and is the most common striation direction recorded. The relationship with striations of the older flow is variable. Normally striae of older flows are found preserved on the lee side of outcrops striated by younger flows. In Petitsikapau Lake, the overall shape of well-exposed polished outcrops reflects southeast flow. Southeast-oriented striae are found on both the northeast and southwest sides of the outcrop, and striae caused by the later northeastward flow are only preserved on the top. A plausible explanation for this anomalous pattern is that the outcrop was completely striated by the southeast flow, which had a major erosive effect. During the later northeast flow, the up-ice side of the outcrop was protected from erosion by a cover of resistant till deposited by the earlier flow. This till has subsequently been eroded by wave action. Alternatively, remnant ice may have protected the up-ice side of the outcrop, with a shear plane developing between the lower static ice, and the upper flowing ice.

Some variation is found from this broad ice-flow pattern, notably in the Dyke Lake–Astray Lake region (Plate 2). A third, older striation set suggesting southward flow is occasionally seen in this area.

The last, northeast flow likely had a source in the area of the Ashuanapi complex or Howell's River valley, west of Schefferville, as it can be traced with little deviation over the area mapped by Liverman and Vatcher (1992) and is probably equivalent to Phase V of Klassen and Thompson (1987). The earlier southeast and south flows are considered to be equivalent to Phase III of Klassen and Thompson (1987), and

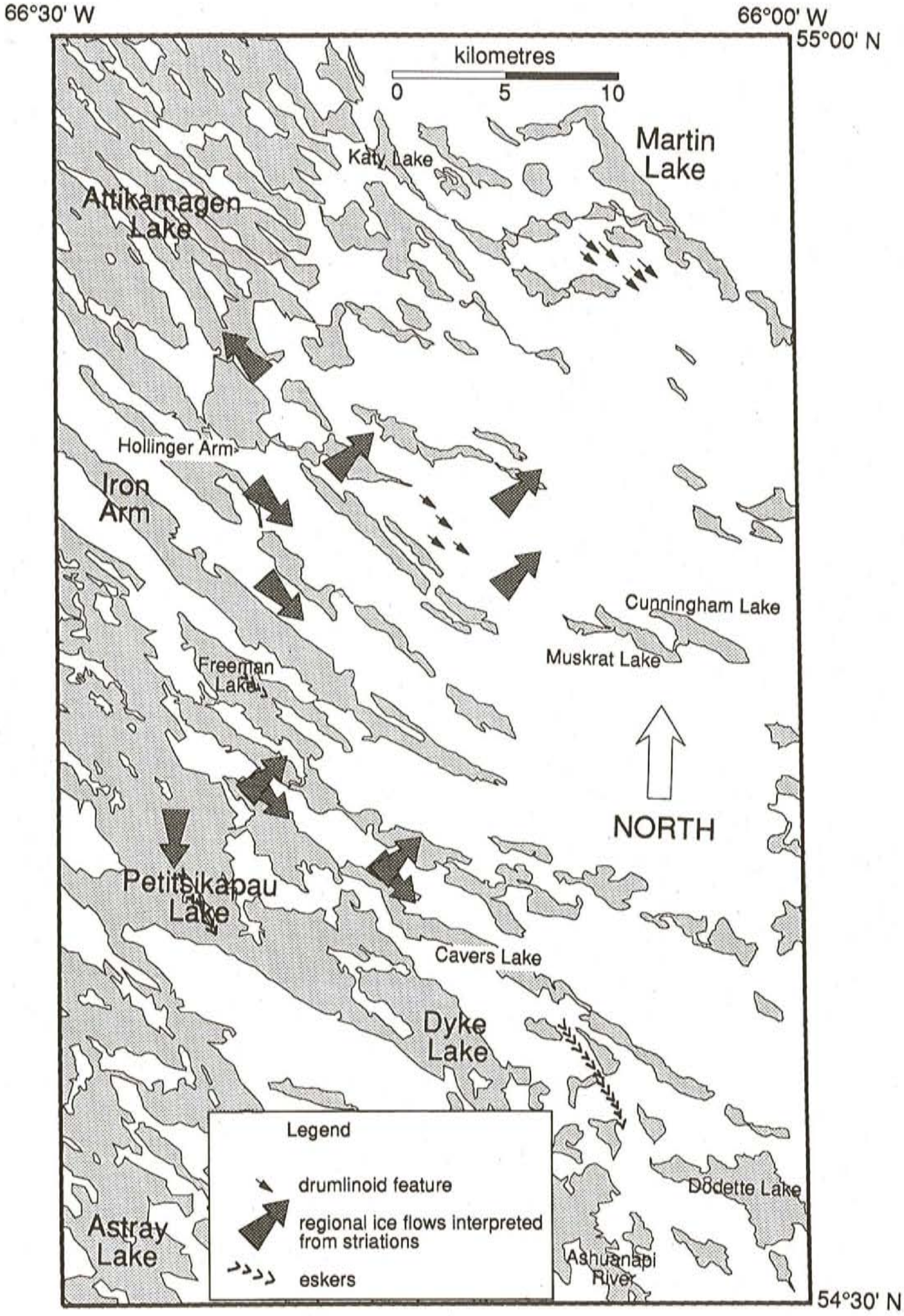

Figure 2. *Main features of study area, showing regional ice flows interpreted from striation evidence.*

consist of flow from an ice centre located within the Labrador Trough in the Schefferville area, possibly migrating to the Attikamagen Lake area at later stages. Klassen and Thompson (1987, *in press*) suggested that the centre was initially located in the area southeast of Attikamagen Lake, but this is not consistent with the striations mapped in this project.

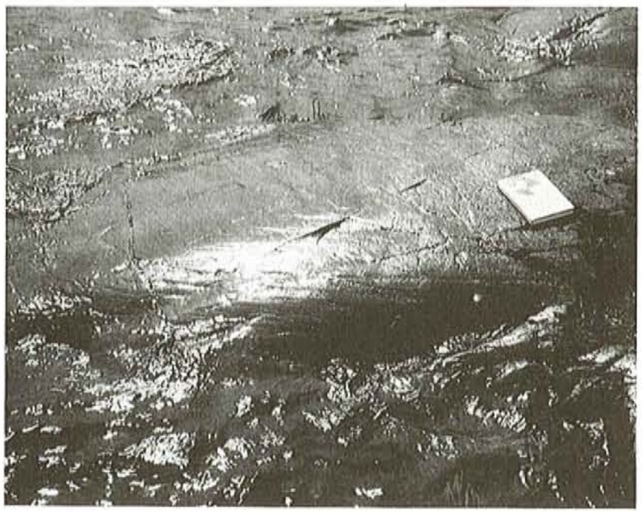

Plate 1. *Striated outcrop at the outlet of Timmins Bay of Attikamagen Lake. Striations oriented northwest–southeast are preserved in the lee of a pervasive northeast ice flow.*

Plate 2. *Complex polished outcrop at the outlet of Petitsikapau Lake. A minature crag-and-tail oriented at 124° has formed in the lee of a boudinaged quartz vein. This has been overprinted by two sets of striae, one set at 168° preserved in the lee of a 40° flow.*

CLAST FABRICS

Only five clast fabrics were obtained in the course of 1992 field work, due to the scarcity of natural sections (Figure 3). Of these fabrics, two were from shallow cleared sections around the Martin Lake showing, two were from a stream cut through a ridge forming part of a ribbed moraine complex at the north end of Dyke Lake, and one was from a small section near the Katy Lake showing. The results are variable (Figure 3). The Katy Lake fabric is strong, unimodal, and suggests ice flow in a northeast–southwest orientation. The two Dyke Lake fabrics were taken from 1.5 m apart vertically, and 5 m laterally. The lower of the two shows that clasts strongly aligned along a northeast–southwest trend, with a tendency toward a girdle distribution. The upper fabric is strongly bimodal, suggesting a north–south-oriented flow, with some clasts aligned transverse to flow. The Martin Lake fabrics were taken from two shallow exposures separated by 30 m. Both are moderately aligned, one showing a mean easterly orientation, with a girdle distribution, the other showing a unimodal northeast orientation.

These results broadly support the contention that the last northeasterly ice flow was the major agent of sediment dispersal, at least in the area of Martin and Katy lakes, and contrast with the results of Liverman and Vatcher (1992) for the map sheet areas west of the study area (who mostly found fabrics related to the earlier southeast flow). The Dyke Lake analyses were from an area of ribbed moraine, with the ribs showing no clear orientation. The lower fabric suggests influence from a northeast flow, but the upper clearly indicates southward flow. The section showed a single massive diamicton unit, and the fabrics are difficult to interpret. The strongly aligned upper fabric suggests that the last ice flow to affect this sediment was southward, not northeastward, but this contrasts with the striation record. This may be evidence of a late southward flow not seen in the striation record.

GEOMORPHOLOGY

Rôches moutonées are found throughout the area, and are commonly oriented with their long axes northwest–southeast, parallel to bedrock strike. Stossing generally suggests ice flow to the southeast, apart from the northern margin of the study area, where outcrops suggest northwesterly flow.

Areas of ribbed moraine are found toward the south end of Petitsikapau Lake, and at the north end of Dyke Lake (Plate 3). In both areas, the moraines form ridges up to 10 m high, and 1 km long. Ribbed moraine in this area is thought to form transverse to ice flow (Ives, 1956; Henderson, 1959; Cowan, 1968). Hand-dug pits indicate that these landforms are composed mostly of diamicton, with a veneer of gravel. This contrasts with the descriptions of Ives (1956) who found ribbed moraine to the south of the study area composed mostly of well sorted sand, and agrees with the findings of Henderson (1959), who studied moraines south of Dyke Lake. The ribbed moraines in Petitsikapau Lake are oriented roughly northwest–southeast, suggesting northeastward ice flow. The Dyke Lake moraines have a more complex morphology, and no dominant orientation is apparent.

Three eskers are found in the study area, one in Freeman Lake, oriented northwest–southeast and 0.5 km long; one in Petitsikapau Lake, 0.8 km long and oriented northwest–southeast; and the third lying between Dodette and Petitsikapau lakes, oriented north–south, and 8 km long (Figure 2). Eskers tend to form perpendicular to the ice margin in the final stages of ice sheet stagnation, and thus, these landforms indicate an east–west-oriented ice margin as the ice sheet stagnated.

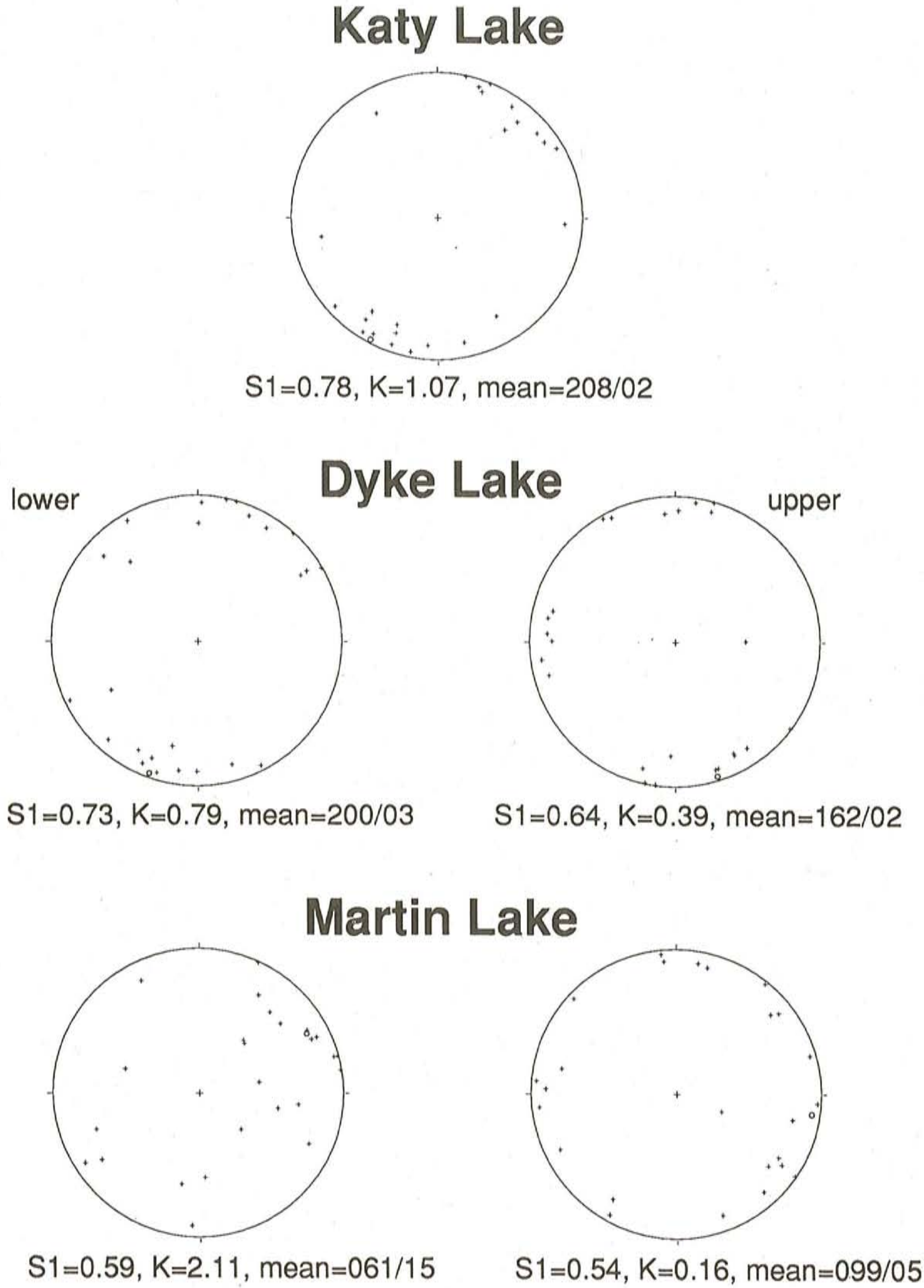

Figure 3. *Clast fabrics from study area. In each case, the orientation of 25 clasts were measured, and plotted onto a stereogram using the Stereo software for the Macintosh microcomputer (MacEachren, 1989). S1 refers to the strength of the primary eigenvector, and thus, the degree of alignment of clasts; K indicates the type of distribution (see Liverman, 1992; and Woodcock, 1977, for details).*

Plate 3. *Ribbed moraine at the southend of Petitsikapau Lake. Moraines have a complex morphology, but suggest deposition by northeast flow.*

Few major meltwater channel systems are found, but they are prominent above Petitsikapau Lake to the west of the study area. These form a series of parallel northwest–southeast channels, curving to the east at their southern ends. Such meltwater channels are suggested to form at the ice margin (Derbyshire, 1959, 1962; Ives and Kirby, 1964; Barr, 1965), and as such indicate that ice was lying in the northwest–southeast-oriented valley at the time of their formation. This is most compatible with a southeastward flow.

The ice-flow history as deduced from geomorphology shows little evidence of the late northeast flow seen in the striation record. As discussed above, it appears that this later flow resulted in little erosion. Although eskers and meltwater channels appear to be related to a southeast flow, it is possible that they formed when the ice mass that last flowed to the northeast stagnated. This ice flow was across regional topography, and thus, ice flow was not parallel to the regional topographic gradient. Meltwater would then respond by flowing to the southeast, and landforms reflecting meltwater influence would be poor indicators of the last ice-flow direction.

CLAST LITHOLOGY

At each sample site, approximately 100 clasts were collected, and later their lithology determined. Two hundred and sixty-four pebble samples were analyzed, giving a regional coverage. The lithology of clasts contained within a diamicton is an indication of the provenance of the material, and indirectly the ice flow responsible for its transport. Ideally, each clast should be related to a definite bedrock source, but in practice this is rarely possible. A definite lithological identification may be difficult to determine from a single clast. For example, in the study area, it was not possible to differentiate greenish siltstones from basalts of similar colour unless the basalts were porphyritic. Bedrock units on a conventional geology map are usually defined on the basis of structural and stratigraphic relationships as well as lithology. Thus, map units may consist of a mixture of rock types, and similar rock types may occur in several units. In the study area, for example, siltstones occur in the Menihek, Le Fer, Sawyer Lake, and Dolly formations. In interpretation of the clast lithology results, only certain rock types can be used as indicators of provenance and ice flow. These must be clearly identifiable in small hand specimens, and originate from a well defined bedrock source. Rock types that fit this criteria in the study area are gabbro, and iron formation. Gabbros are distinctive, and are only found within the Montagnais Intrusive Series and the Nimish Formation (Wardle, 1982). They are common in pebble samples, averaging 15.5 percent. Iron formation is characterized by high bulk density, and magnetic properties, and is restricted to the Sokoman Formation. The area of iron-formation outcrop within the study area is small, but the rock type is resistant and is reasonably well represented in pebble samples, averaging 4.4 percent.

The distribution of gabbro within surface diamictons is controlled by the distribution of gabbro outcrop, and the ice-flow history (Figure 4). The southern half of the study area contains only minor gabbro outcrops, and few samples from this area contain gabbro. Sporadic occurrences of relatively high gabbro percentages suggest unmapped gabbro outcrops may exist in the area east of Petitsikapau Lake, or relate to long-distance southeasterly transport. High percentages of gabbro in diamicton are common in the north half of the map area, where gabbro outcrops are common. High percentages of gabbro clasts generally occur along the eastern margins of mapped outcrops, with gabbros in diamicton low to absent over outcrop to the west of the mapped extent. This suggests that the later northeastward flow has been a significant influence on clast provenance. High percentages of gabbro are found throughout the Attikamagen Lake basin, although no outcrop is mapped in this area. This pattern may be explained by southeasterly transport from extensive gabbro outcrops 20 km northwest of the study area; or more likely by northeast transport from the outcrops of gabbro mapped on the west of the study area.

The distribution of iron formation is also interpreted to show northeastward dispersal (Figure 5). The north part of the study area shows numerous samples with significant iron formation, well to the east of the outcrop of this rock type. No bedrock source exists up-ice of a southeasterly ice flow, and thus, these clasts were likely transported by the later northeasterly flow. Iron-formation clasts are common close to the area of its outcrop in the south of the area, and are particularly common in the Fawley Lake–Astray Lake area in the southwest of the study area. There is no mapped iron formation in this area, but extensive outcrops are found west of these sample locations, again suggesting eastward dispersal.

Thus, clast lithology indicates dispersal by northeastward ice flow. The striation record suggests that the northeastward flow was the last affecting the area, and this is the major control on dispersal. Phases I and II of Klassen and

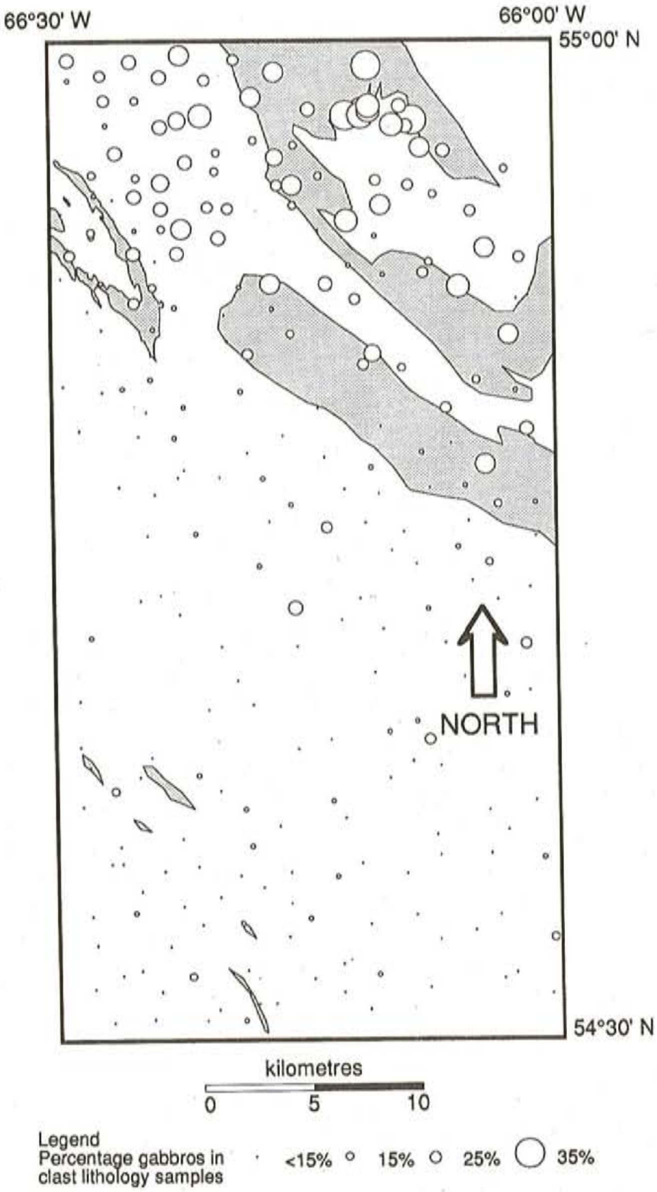

Figure 4. *Plot of gabbro clasts in surface diamictons for the study area (264 samples). Shaded area represents outcrop of gabbro.*

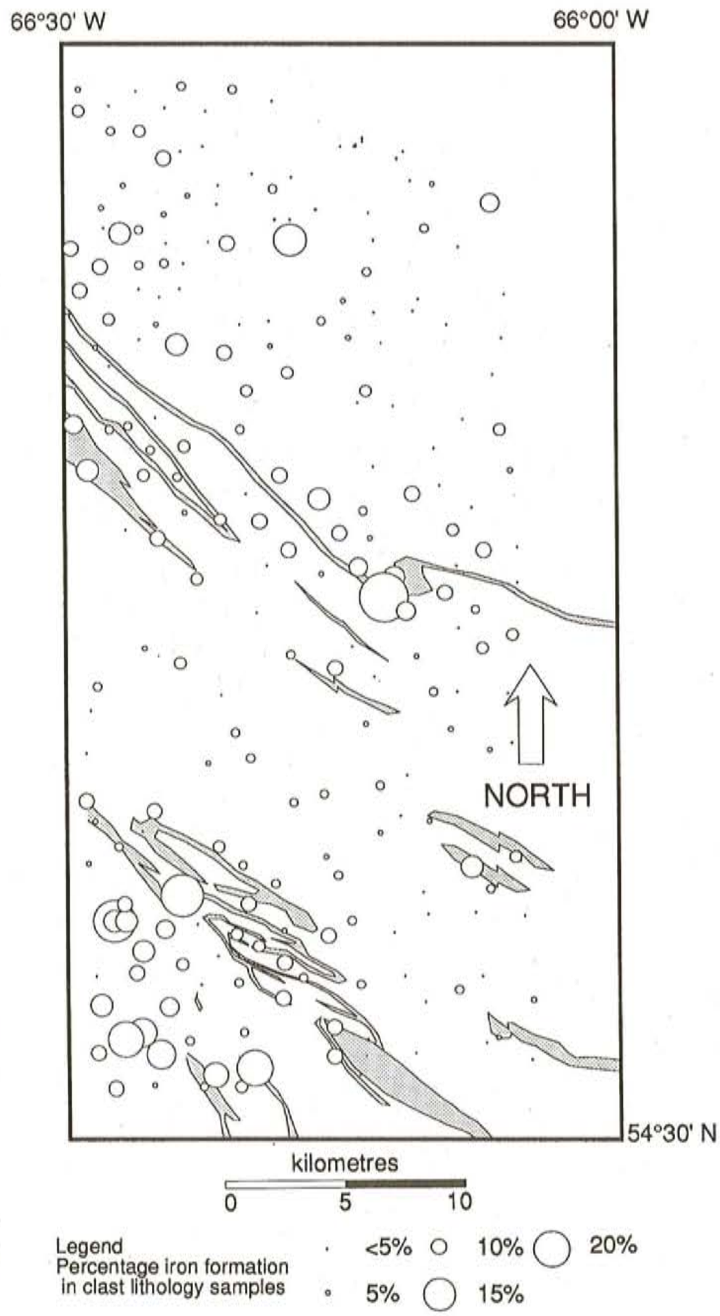

Figure 5. *Plot of iron formation clasts in surface diamictons for the study area (264 samples). Shaded area represents outcrop of iron formation.*

Thompson (1987), however, also are suggested to show a northeast flow in the study area, and may have had some effect on the dispersal pattern.

Klassen and Thompson (1987, *in press*) suggested that the dispersal pattern of a distinctive red porphyritic rhyolite exposed in the Martin Lake area indicated westward and northward flow. Clasts of this rock type were commonly found up to 10 km west and 5 km north of its known outcrop in this study, confirming dispersal in these directions.

SURFICIAL GEOLOGY

The surficial geology of the study area is variable, and controlled in part by bedrock geology and topography (Figure 6). Areas underlain by softer bedrock are low lying, and have a substantial surficial cover of diamicton and bog. The more resistant bedrock form higher ground, and have a patchy surficial cover of diamicton and bog. Exceptions to this pattern are the low-lying areas at the north end of Petitsikapau Lake, and the area lying between Cunningham and Dodette lakes (Figure 2), where the surface cover consists of frost-shattered bedrock having little or no surficial cover, interspersed with bogs. Glaciofluvial sediments are rare, restricted to three esker systems, the largest of which is 8 km long, and is found east of Petitsikapau Lake, in the south of the study area.

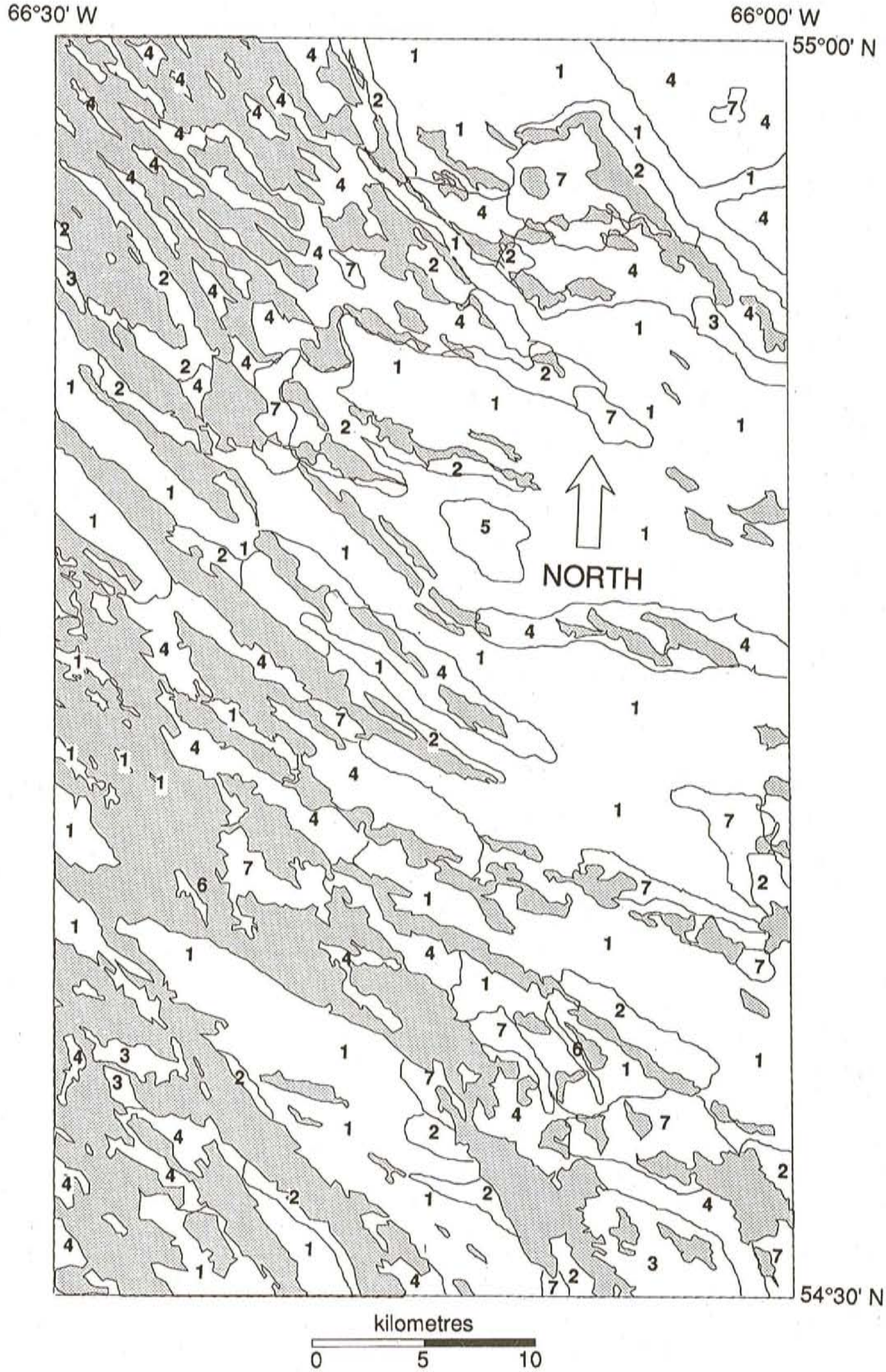

Figure 6. *Simplified surficial geology map for the area. 1 = mostly bedrock, 2 = till veneer, 3 = hummocky or ridged till, 4 = till plain or blanket, 5 = drumlinised till, 6 = glaciofluvial gravel, 7 = bog.*

Wetlands of various types are found throughout the area, and even well-drained sites have a thick organic surface layer overlying mineral sediment. Several large bogs and fens are found, notably west of Martin Lake, and east of Petitsikapau Lake, but smaller wetlands are found throughout the area, particularly in association with low-lying areas. An indication of the extent of wetlands is that, of the sampling pits, 20 percent penetrated organic or gleyed soils, despite sites being chosen so as to avoid poorly drained areas.

Diamicton is the most common surficial sediment, and is variable in character when examined in hand-dug pits. The matrix varies from 30 to 80 percent by volume, averaging 60 percent, and contains from 10 to 50 percent silt and clay. The matrix colour is also variable, but is most commonly 10YR 4/3 (brown) to 10YR 4/4 (dark yellowish brown) in the south of the study area, and 2.5 Y 3/2 (very dark greyish brown) to 2.5Y 4/2 (dark greyish brown) in the north of the study area (all colours obtained on moist samples using the Munsell colour book). This variation likely reflects bedrock geology, with the north of the study area mostly underlain by grey and black shales of the Menihek and LeFer formations, and the south underlain by the more iron-rich rocks of the Nimish and Sokoman formations. To determine the genesis of these surface diamictons requires examination of well exposed sections through it. Only two such sections were found in the field area. Well oriented clast fabrics from these sections suggest that in these locations, diamicton was deposited as basal tills. It would be unwise to extrapolate these results over the entire field area without further studies.

EVIDENCE FOR GLACIAL LAKES

In the area of Attikamagen and Petitsikapau lakes, hand-dug pits typically show a layer of granules, pebbles and cobbles, from a single clast to 30 cm thick, overlying diamicton (Plate 4). This gravel veneer is mostly open work, although a sand matrix is sometimes found where the veneer is thicker. Clasts in this veneer are of similar rock type and shape to those found in underlying diamictons. This stratigraphy is only found in sites at elevations within approximately 20 m of modern lake level. This gravel veneer is interpreted to be formed at higher lake levels, when drainage was dammed, probably by ice. The shoreline of Attikamagen Lake is generally of low gradient, and higher lake levels would result in a wide area being exposed to the effects of reworking by wind-generated bottom currents. Such currents have winnowed all the silt and clay from the surface diamicton, leaving a gravel lag. Indistinct beach development seen on aerial photographs provides further evidence of higher lake levels. Investigation of these beaches near Petitsikapau Lake showed two benches, flat topped, and composed of moderately sorted open work pebble to cobble gravel. Well sorted sand and gravel were encountered in several pits along the east side of Martin Lake, and may also be related to higher lake levels.

Higher lake levels in this area have previously been identified by Slipp (1952) in Petitsikapau Lake, Usher (1953) in Astray Lake, and Henderson (1959) in Astray and Menihek

Plate 4. *Washed veneer of pebbles and cobbles, typical of many pits dug around Attikamagen and Petitsikapau lakes. It is suggested that finer material has been winnowed by bottom currents in higher levels of these lakes, caused by damming of drainage by remnant ice.*

lakes. Henderson (1959) describes beaches at approximately 15 m above Astray Lake, and from 3 to 20 m above Menihek Lake. Slipp (1952) identified beaches at approximately 15 m above Petitsikapau Lake. Henderson (1959) suggested that drainage was blocked by remnant ice at the outlet of Astray Lake, and at the southern outlet of Dyke Lake.

To form a glacial lake, drainage must have been blocked by ice. The present drainage of the entire lake system is to the south via Dyke Lake and the Ashuanapi River. The drainage divide between this system and the George River to the north is less than 5 m above Attikamagen Lake. Thus, elevated lake levels may have been caused by damming of drainage to the south of the field area by remnant ice, or by isostatic depression resulting in postglacial drainage reversal. The pattern of meltwater channels suggests that ice retreated northward (Henderson, 1959; Ives, 1960). Existing shorelines in the study area are poorly defined, and assessment of isostatic tilt is not possible. Andrews and Peltier (1989) show a northwestern trend of increasing isostatic depression over Labrador Ungava. Shorelines in the George River basin, well to the north of the study area show a tilt of approximately 0.1 to 0.2 m/km to the north (Ives, 1960; Matthew, 1961). If a similar degree of differential rebound has occurred in the Schefferville area, then it is likely that drainage was to the north following deglaciation. If this were so, then the presence of elevated lake levels can be reconciled with the suggested pattern of ice retreat, as northward drainage was blocked by northward retreating ice.

CONCLUSIONS

Ice flow in the area has been investigated by mapping of striations, geomorphology, clast lithology in diamictons, and clast fabrics. Two major ice flows have affected the area, an early southeast to south flow, and a later northeast to east flow. The southeast flow was parallel to bedrock strike and has had a major effect on the geomorphology of the area, sculpting bedrock surfaces, but leaving only a fragmentary striation record. Most polished bedrock surfaces are covered by striae relating to the later northeastern flow, which also appears to be the dominant agent of dispersal of surface diamictons. The presence of striations related to the earlier flow on both sides of some bedrock outcrops suggests that patches of till related to this flow may also be preserved.

The present lake basins were enlarged by damming of drainage by retreating glacial ice following deglaciation, and it is suggested here that differential isostatic rebound resulted in reversal of drainage, with most of the lakes draining north to Ungava Bay. Considerable reworking of surficial sediment took place at the margins of these lakes.

RECOMMENDATIONS FOR MINERAL EXPLORATION

In mineral exploration, knowledge of the surficial geology is important in interpreting the results of geochemical soil sampling, and in tracing mineralized boulders to their source. The preliminary results presented here suggest that the later northeastward ice flow is the main agent of dispersal of surficial sediment, and should be the main direction considered in the interpretation of the geochemical data obtained through soil sampling. The possible preservation of diamicton associated with the southeasterly flow suggests that this alternative must also be considered. The lack of deep erosion associated with the later ice flow, and the complex regional ice-flow history proposed by Klassen and Thompson (1987, 1989, *in press*) will make tracing of individual boulders to a bedrock source difficult. It is expected that the later flow would rework boulder dispersal trains deposited by the earlier flow, but with little erosive power, would not produce distinctive boulder dispersal itself.

Care should be taken in sampling, especially around the margins of the major lakes in the area. B-horizon sampling in these areas may be strongly affected by current reworking in higher stands of the lakes, with winnowing of fines. To obtain results that are consistent, samples should be taken from the C-horizon.

These results are preliminary, and more definite conclusions regarding geochemical dispersion in the area will be made after analysis of samples.

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