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Résumé de l'article

À l'aide d'analyses statistiques de l'orientation des galets dans les formations glaciaires et de l'étude des formes mineures d'érosion glaciaire (roches moutonnées, stries, fissures de pression), l'auteur décrit les modalités de la dernière déglaciation dans la région de Schefferville. — La convergence des formes glaciaires dans cette région est imputable soit au fait qu'elle était, au cours de la dernière glaciation, un centre de dispersion de la glace, soit au fait qu'elle était, lors de la déglaciation, à cause des facteurs topographiques locaux, une zone occupée tardivement par des culots de glace. Ainsi, si l'écoulement de la glace s'effectuait, de façon générale, depuis des directions à composante ouest, ceci n'est pas le cas dans toute la région. Localement, comme aux alentours du lac Kivivic, la morphologie glaciaire se caractérise surtout par des formes de décrépitude créées par des culots de glace au cours des stades finaux de la dernière déglaciation.

# MOVEMENTS OF ICE
# IN CENTRAL LABRADOR-UNGAVA

*by*

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## Résumé

*À l'aide d'analyses statistiques de l'orientation des galets dans les formations glaciaires et de l'étude des formes mineures d'érosion glaciaire (roches moutonnées, stries, fissures de pression), l'auteur décrit les modalités de la dernière déglaciation dans la région de Schefferville. — La convergence des formes glaciaires dans cette région est imputable soit au fait qu'elle était, au cours de la dernière glaciation, un centre de dispersion de la glace, soit au fait qu'elle était, lors de la déglaciation, à cause des facteurs topographiques locaux, une zone occupée tardivement par des culots de glace. Ainsi, si l'écoulement de la glace s'effectuait, de façon générale, depuis des directions à composante ouest, ceci n'est pas le cas dans toute la région. Localement, comme aux alentours du lac Kivivic, la morphologie glaciaire se caractérise surtout par des formes de décrépitude créées par des culots de glace au cours des stades finaux de la dernière déglaciation.*

## Introduction

Glacial flow features over the Labrador peninsula show in general a fairly simple, if not entirely decipherable, pattern. Most of this pattern is at present based on aerial photographic interpretation and it remains to be seen how far the simplicity is real and how far the result of lack of more detailed information. In the centre of the peninsula within 50 miles radius of Schefferville, it is recognized that the pattern is far from simple and, although relatively more fieldwork has been done in this area, the available evidence and conclusions are by no means definitive.

The general pattern of glacial-flow features over the peninsula, as shown by Douglas and Drummond (1953), the Glacial Map of Canada (Wilson, *et al.*, 1958), and Hare (1959), suggests movement radially outwards through the southern part from an area in the centre or north-centre. This dispersal area is popularly known as an ice-divide ; for example, it is in the sense of an ice-dispersal centre that a zone of Central Labrador-Ungava has been described as an ice-divide on the Glacial Map of Canada. Such a concept of an ice-divide envisages a median zone separating active ice movements in different directions, but not itself necessarily suffering active ice movement, at least until the glacier margins have retreated to close proximity.

In the context of this paper however, it is important to note that the term « ice-divide » has also been used to describe the area occupied by the last glacial remnants of a continental ice sheet, both in the case of the Keewatin ice sheet (Lee, Craig and Fyles, 1957 ; Lee, 1959), and for the Labrador ice sheet (Ives, 1959), and that the area defined by « ice-divide » in its two senses need not necessarily correspond. Radial movement outward from one area might be followed by retreat to another area. In Scandinavia, for instance, the centre of the ice sheet at its maximum extent was far to the east, probably over the Gulf of Bothnia, but the final area of ice, still existing today as active centres, is in Western Sweden and Eastern Norway (Hoppe, 1959) ; the centre of activity therefore changed location during deglaciation. It may well be that a principal ice-dispersal area will also become the ice-remnant area, but this is not necessary, and can be guaranteed to occur only if the dispersal movement is a late movement that can be related directly to the deglaciation and to the retreat of the ice margins.

In Labrador-Ungava, the indicators of glacial movement, principally striations and drumlins, agree exactly in direction with the pattern of eskers marking the retreat of the margins (Glacial Map of Canada) and on this evidence, Central Labrador-Ungava does appear to be both a node area of ice dispersal and the site of the last glacial remnants.

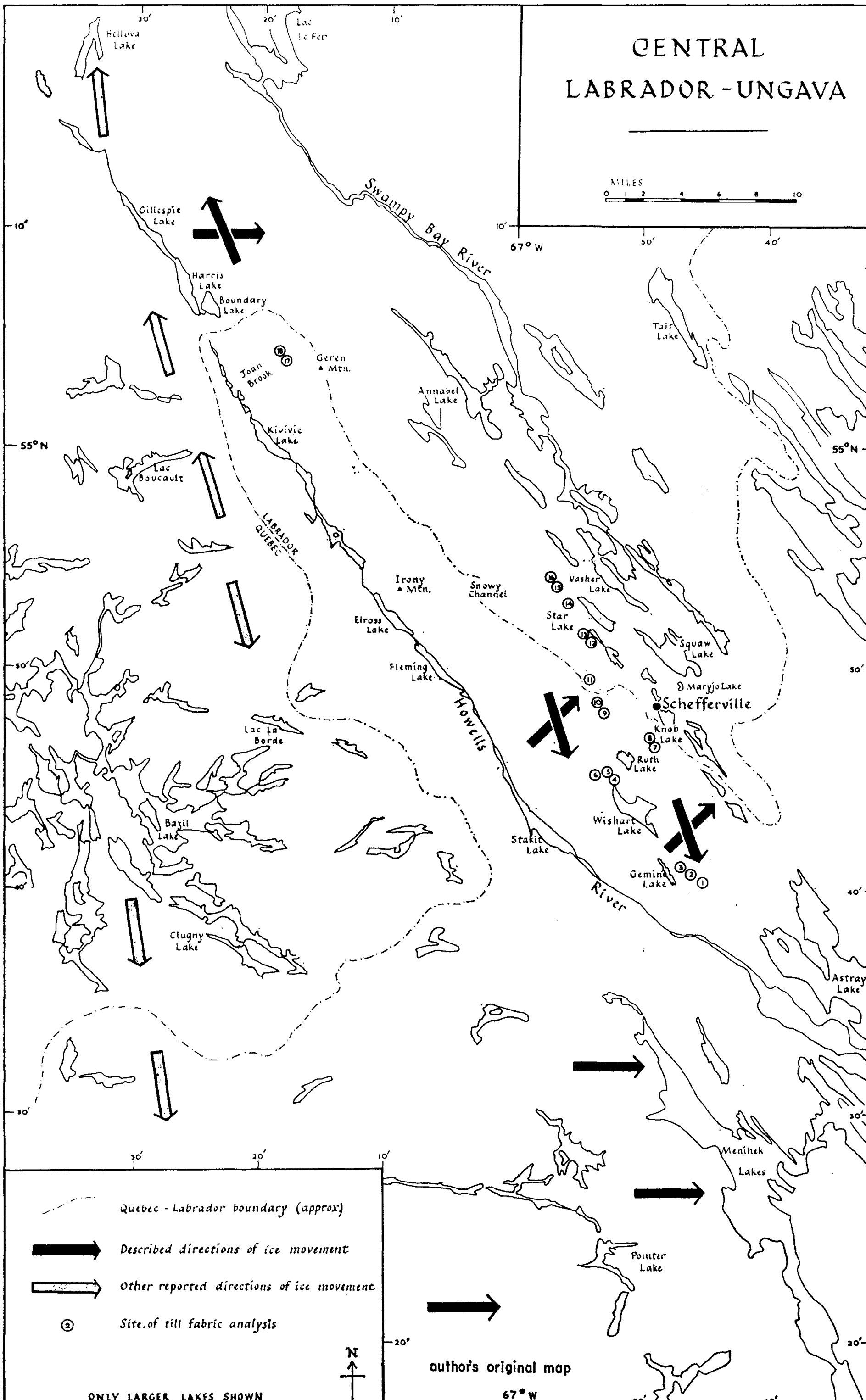
Independent evidence apart from the esker pattern suggesting that Central Labrador-Ungava was an ice-remnant area, among one of the latest to be deglaciated, has been put forward by Grayson (1956) by palynology ; by Derbyshire (1959) and Ives (1959) from examination of glacial drainage channels ; by Henderson (1959) from general considerations ; and by Kirby (1961) from an investigation of features of the drift cover.

Ice dispersal from the area is inferred from the radial pattern of glacial flow features, but it is not yet known at what stage of the glaciation this pattern was produced. It may considerably predate the deglaciation, or it may be directly related to it ; its significance can be appreciated only in the more general chronology of the glacial history. Therefore, following the more specific evidence on ice movements presented below, some attempt is made to interpret the ice-movement pattern in terms of the complete glaciation.

## Till fabric evidence of ice movement

Photo interpretation of selected areas on the granite-gneisses west of the Labrador Trough shows strong but contrasting directions of ice movement (Figure I). West of Menihek Lakes, drift tails plotted from aerial photographs by the writer indicate movement from west to east ; this is the same direction of movement as found further west, but to the north around Lakes Avezac and Clugny, the trend was apparently north-south. Closer to the Howells Valley, west of Kivivic Lake, there are many excellent drift tails indicating movement to the north (J. D. Ives, personal comm.). From the district west of Elross Lake, Fox (1958) has described *roches moutonnées* that indicate movement to the south. In part, this area overlaps the area further north where movement to the north is described, and so the evidence or its interpretation here is contradictory. Aerial photographs will normally show evidence of only the beat

FIGURE I




Directions of ice movement within 50 miles of Schefferville.

preserved direction of ice movement, which is commonly the latest, and so some of the directions recorded above may in fact be more compatible than at first appears.

In the light of these various movements west of the Labrador Trough, fresh observations of the direction of ice movement were made over an area within 30 miles of Schefferville. Mining operations have provided some opportunity of access to the district neighbouring the townsite, especially in the directions northwest and southeast along the strike of the Trough, and in this area both erosional and depositional indicators of ice movement have been studied.

Detailed till fabric analyses of the ground moraine were carried out to discover the direction or directions of movement of active ice in the region. With the exception of two analyses in a deep valley, the till fabric sites were chosen carefully either on the crests of ridges or on flat and open ground in order to avoid the possibility of any solifluction effects. Also, wherever possible, the analyses were carried out at least three feet from the surface to eliminate disturbances of the till due to frost heaving (Figure II). At sites where the thickness of till is less than three feet, the analyses were carried out as low as possible clear of bedrock, and the plotted results show no abnormalities. At each site, the azimuth and dip of the long axes of 100 suitably shaped particles were measured. Contiguous particles and particles with long axes dipping in excess of 60° were rejected. Measurements were made to 1°, the complete investigation of one hundred particles requiting 3½ to 5 hours. The measurements were plotted on polar equal area nets (Figure III) on which the radial scale represents dip and the circumferential scale azimuth. The resulting scatter diagrams of axial plots give a good visual impression of the fabric characteristics. A statistical test derived from Harrison (1957*a*) was then applied to decide whether or not there is a preferred orientation and to establish the exact direction of preferred orientation, should it exist.

A summary of the results of the till fabric analyses is given in Table I. From a total of eighteen fabric analyses in ground moraine, fourteen show a strong preferred orientation between northwest-southeast and north-south (Figure III ; numbers 1-12, 14, and 16). A group of two or three fabric analyses was carried out in each locality and in each case, the directions of orientation are consistent to 20°. The trend of what is shown below to be the last ice movement is therefore generally north-northwest – south-southeast. The dip direction of particles did not prove to be an accurate indicator of direction (as opposed to mere trend) of ice movement in this area.

Of the remaining four analyses, two at Star Ridge (Figure III ; numbers 13 and 15) both indicate orientation northeast-southwest, an anomaly that, if it cannot be explained in terms of the other evidence, may at least be considered relatively insignificant, as both occur in proximity to other fabric analyses showing the more typical north-northwest – south-southeast trend.

The final two analyses from ground moraine (Figure III ; numbers 17 and 18) taken at Joan Brook just north of Kivivic Lake and much further northwest than the others, show no preferred orientation at all. The significance

TABLE I

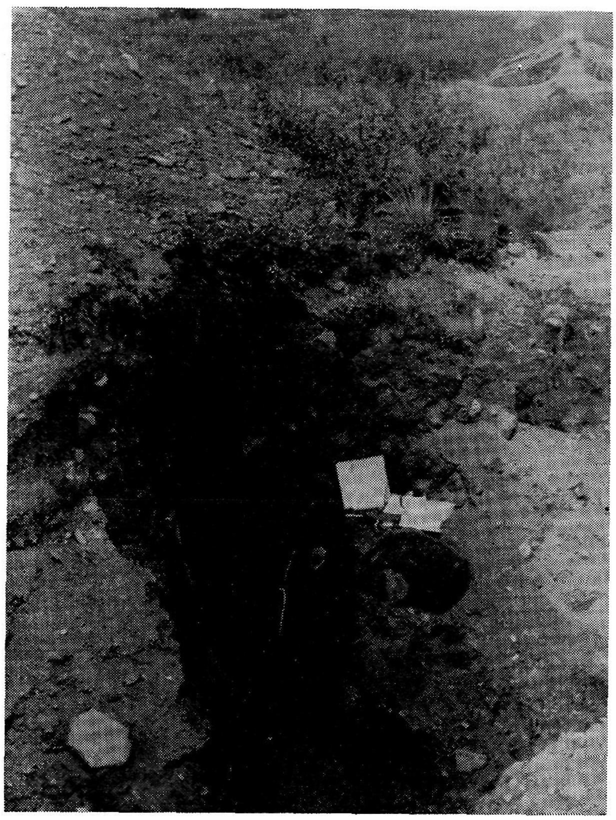
*SUMMARY OF TILL FABRIC ANALYSES FROM GROUND MORAINE*

| Till fabric analysis | Location and site | Working depth and total depth of drift (ft.) | Slope of surface | Strength[1] of orientatuon | Apparent[1] preferred orientation |
|---|---|---|---|---|---|
| 1 | REDMOND,/E. of Gemini Lake. | 3/4 | N.E. 2° | 66 | N.133E. |
| 2 | | 5/7 | N.E. 2 – 3° | 57 | N.143E. |
| 3 | In line along ridge crest. | 5/7+ | N.E. 2 – 3° | 32 | N.135E. |
| 4 | North end of Wishart Lake. | 1½/2 | Horizontal | 59 | N.156E. |
| 5 | | 2/2½ | Horizontal | 81 | N.160E. |
| 6 | Open low ground. | 3½/4½ | S.W. gently | 68 | N.138E. |
| 7 | SILVERYARDS,/E. of Ruth Lake. | 3/4 | Horizontal | 51 | N.148E. |
| 8 | Floor of deep narrow valley. | 8/13 | N.E. 5° | 91 | N.162E. |
| 9 | FERRIMAN,/W. of Schefferville. | 4/8 | S. or S.E. 6, gently S.E. 4 | 21 | N.170E. |
| 10 | Side of quarry. | 4/8 | S.E. 4° | 33 | N.163E. |
| 11 | FERRIMAN,/W. of Schefferville. High open ground. | 2½/3½ | W. 8° | 49 | N.171E. |
| 12 | STAR CREEK. Shelf of level ground. | 8/13 | Horizontal | 15 | N.162E. |
| 13 | STAR CREEK. Hilltop site. | 2½/5 | N. 1 – 2° | 40 | N.222E. |
| 14 | | 2/5 | N. 2° | 19 | N.191E. |
| 15 | STAR RIDGE. Ridge-top site. | 5/6 | Horizontal | 20 | N.211E. |
| 16 | | 2/6 | Horizontal | 19 | N.180E. |
| 17 | JOAN BROOK. Open ground. | 4/5 | S.W. 5° | — | — |
| 18 | | 4/6 | S.S.E. 4 – 5° | — | — |

1. As determined by statistical test.

of this is difficult to estimate. Lack of particle orientation in undisturbed ground moraine suggests deposition from stagnant or stationary ice, but as the actual mechanism of till deposition is as yet little understood, it would be rash to be more specific. The two opposing theories of till deposition are deposition by lodgment, or « plastering-on », the more favored hypothesis (Flint, 1957) and deposition by melting-out of englacial material, for which support has recently revived (Harrison, 1957*b*). By either theory, it is a necessary condition that the ice should have been moving only very slowly or not at all for the development of a fabric lacking orientation.

FIGURE II



The site of till fabric analysis 3 at Redmond near Germini Lake.

This condition may reasonably be expected at an ice divide, where deposition is under semi-stationary conditions at the point where ice begins to flow outwards in opposite directions. The two fabric analyses with random orientation at Joan Brook may therefore be said to give some support, albeit weak, for the former existence of an ice divide, as envisaged by Ives (1959), in this locality.

## EROSIONAL EVIDENCE OF ICE MOVEMENTS

Within a 5-mile radius of Schefferville, both in the Schefferville depression and on the hilly belt immediately to the west, there are two contrasting sets of striations (Figure IV). North-northwest striations are by far the more common set, showing as fine shallow scratches on slate, coarse grooves on quartzite and often as a smooth polish on the harder iron formations. The more brittle rocks also show good crescentic fractures and crescentic gouges. Poorly developed *roches moutonnées* occur widely. The striations, the crescentic marks and the glacially plucked surfaces of the *roches moutonnées*, all indicate movement from the north-northwest.

Southwest striations comprise the second set found near Schefferville. These occur less frequently and only in conjunction with the north-northwest set. The direction of ice movement is less obvious, but was finally determined as being from the southwest, from examination of large crescentic gouges and from the greater abundance of these striae on west-facing stoss surfaces.

The strong predominance of north-northwest striations, their fineness compared with the coarse grooves of the southwest set, and the absence of *roche moutonnée* forms with plucked northeast faces, all indicate that the north-northwest striations are the more recent set. Direct comparison between the two sets only once gave conclusive evidence : by Maryjo Lake, north-northwest striations are engraved within and therefore postdate a large crescentic gouge associated with the southwest striations.

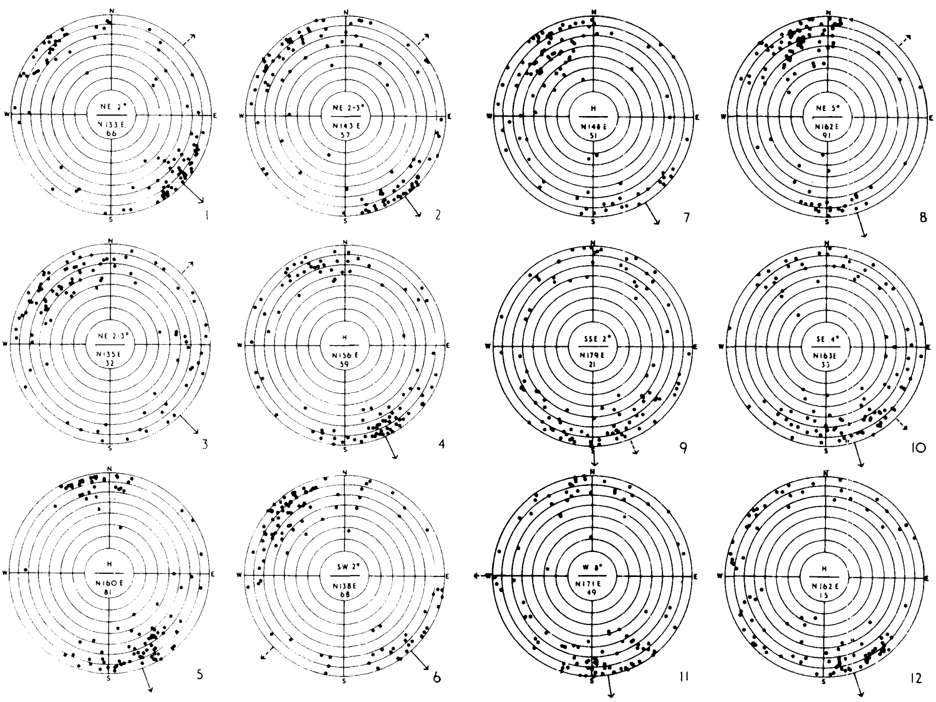
The striation pattern may be immediately correlated with the results of the till fabric analyses. The north-northwest direction of the more recent set of striations clearly agrees with the direction of preferred orientation obtained west and southwest of Schefferville by Fabric analyses 1 to 12 (Figure III). The till itself has therefore been deposited in connection with the last ice movement, from the north-northwest. The striation evidence also eliminates the possibility, not satisfactorily resolved from the dip of the till fabric particles, that the movement of ice was from the opposite direction, the south-southeast.

In spite of the evidence from striations for at least two directions of ice movement, there is no field evidence to suggest the existence of more than one till layer. On the north side of Wishart Lake, the two regional sets of striations are superimposed, the older set trending N.40-47°E. and the more recent set trending N.30°W. Two till fabric analyses (Figure III ; numbers 4 and 5) were carried out at Wishart in the thin drift at points very close to the location of the striae. Both fabric analyses show strong preferred orientation, respectively N.24°W. (N.156°E.) and N.20°W. (N.160°E.), corresponding to the more recent set of striations. Neither at Wishart nor anywhere also was there found till with a fabric orientation corresponding with the southwest striae. This sould seem to suggest that till was not deposited from earlier phases of ice movement, and that the different sets of striations merely represent shifts in the direction of ice movement, possibly related to variations in thickness of the ice sheet. This conclusion is also reached by Ives (1960*a*). Glacial erosion in the area appears to have been slight ; it appears unlikely that an earlier till sheet was deposited and then removed by a later ice movement in a different direction.

The above evidence on directions of ice movement does not entirely agree with the conclusions of other workers. Harrison (1952) records that within a few miles of Schefferville, ice movement was in turn from the northwest, southeast and finally southwest. Henderson (1959) finds no evidence to support Harrison's suggestion of movement from the southeast, at least within a 5-mile radius of Schefferville, but does agree with the other movements, the older from the northwest and the younger from the southwest. It is suggested in this study that although these directions are substantially correct, they are in the wrong order. In pointing out that the dominant movement was from the north, Syme (1951) evidently meant that this was the most clearly represented, as is certainly the case.

From the area between Kivivic Lake and Helluva Lake, a further shall number of striation measurements were recorded. The striations show an earlier movement of ice trending approximately east-west with movement pro-

FIGURE III



Till fabric diagrams. The circumferential scale represents orientation ; the radial scale re
and amount of surface slope of the ground upper part of central circle and broken arrow and
tation (lower part of central circle and solid arrow). See also Table 1. The locations of the

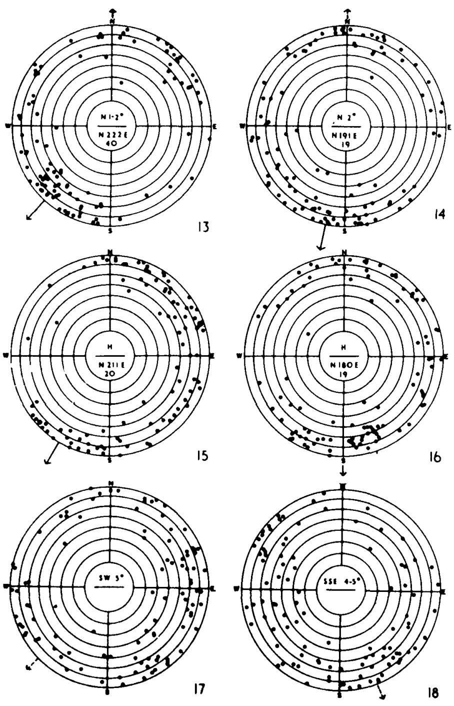
bably from the west, followed by a movement from the south-southeast. As for the Schefferville area, the conclusions for direction and relative age are drawn mainly from the abundance and fineness of the two sets of striations and from crescentic markings and *roche moutonnée* forms.

Henderson examines the glacial-flow features in this district (1959 ; page 2 and Figure II), and also lists the reports of mining company geologists who had previously worked here ; the trends if not the directions proposed by these workers are generally supported by the present proposals. In the Helluva Lake area itself, the final ice movement has been found to be to the north (Ives, 1960*c*).

From the striation and till fabric evidence, it may be concluded that the final movements of ice were outwards in diametrically opposed directions north-

north-west and south-southeast from the latitude of Kivivic Lake. This supports the concept of an ice-dispersal centre in this locality. However it seems clear that this centre could only have been a late glacial feature, for the penultimate movements all over the area were from a westerly quadrant, and therefore intolerant of any east-west boundary at this time.

FIGURE III (*Cont'd.*)




presents dips. Also shown are the direction the directions and strenght of preferred orientill fabric sites are shown in Figure 1.

### TOPOGRAPHIC CONTROL OF ICE MOVEMENT

It is thought that the climate during the final period of deglaciation was similar to or possibly more mild than the climate today (Manley, 1955); the waning ice sheet of this period would therefore correspond to a temperate or « warm » glacier of today, the ice being at the pressure-melting point. It has been found in temperate glaciers and so would have held also for the melting Labrador ice sheet, that the depth at which plastic flow commences is not more than 30 metres, while the minimum load necessary to produce continuous movement may be of the order of 45 metres or less. As the local relief in the Schefferville area is often 500 feet or more, it is probable that, as the ice sheet thinned, it became divided between the ridges into a number of parallel tongues of ice still sufficiently thick to continue flowing. Flow would then cease to be outwards normal to the earlier ice margins but would be guided solely by the local topography.

The local evidence seems to support this concept of topographic control of ice movement. The penultimate direction of ice movement, of which there is a record both on the hilly belt and in the Schefferville depression, is directly transverse to the Trough ridges and valleys ; the local relief had evidently not been able to exert any control at this time. But the last movement, as shown by striae and till fabric analyses, is actually or approximately in the same direction as the alignment of the Trough itself.

This movement is again an overall movement, occurring both on the hilly belt and in the valleys. It was not found that the late movements along valleys of the Trough could be distinguished from overall regional movement in the same direction but, in view of the accordance of direction, it seems possible that the last overall movement was induced by the structural lineation, and that the topography was exerting considerable guidance over direction of movement, much as a tram is guided by the tramlines beneath it, even before the highest ridges were exposed.

Till fabric analyses numbers 7 and 8 (Figure III) were purposely carried out on the floor of a deep narrow valley at Silveryards. The fabric orientations at these sites are closely in accordance with the direction of the valley itself, suggesting strong directional control. The analyses were taken respectively near the top and base of the till, which is in some places exceptionally thick here. The two scatter diagrams have a very similar visual appearance. If this till were deposited by continuous accretion, as the lodgment theory proposes, then the ice movement along the valley may have been long continued, the top layers of till having been deposited at a late phase when the regional ice-sheet had begun to break up. Late local ice movements along the valleys throughout the area from Helluva Kake to Menihek Lakes have been suggested by Henderson (1959, pp. 66-68), although the various directions of movement proposed do not always agree with the present contentions.

The process of increasing topographic control would produce a final ice divide at right angles to the strike of the Trough rocks. This is in fact found to be the case by Ives (1959). But topographic control can be invoked only within the Trough system, for the granite-gneisses have no dominant lineation to affect movement in this way. It may be noted that in Northern Sweden, an area where the phases of continental ice recession are well documented (Hoppe, 1959), there was no topographic control of ice movement at early stage of deglaciation, but with eventual fragmentation of the ice sheet into a number of pieces in the valleys, there began movement in different directions along the valleys. Because of the lack of a dominant structural lineation, there is no correspondence between the direction of last regional movement, as shown on the mountain tops, and the several directions of movement along the valleys at a very late stage. The same lack of correspondence is to be expected over the granite-gneisses of the Labrador peninsula.

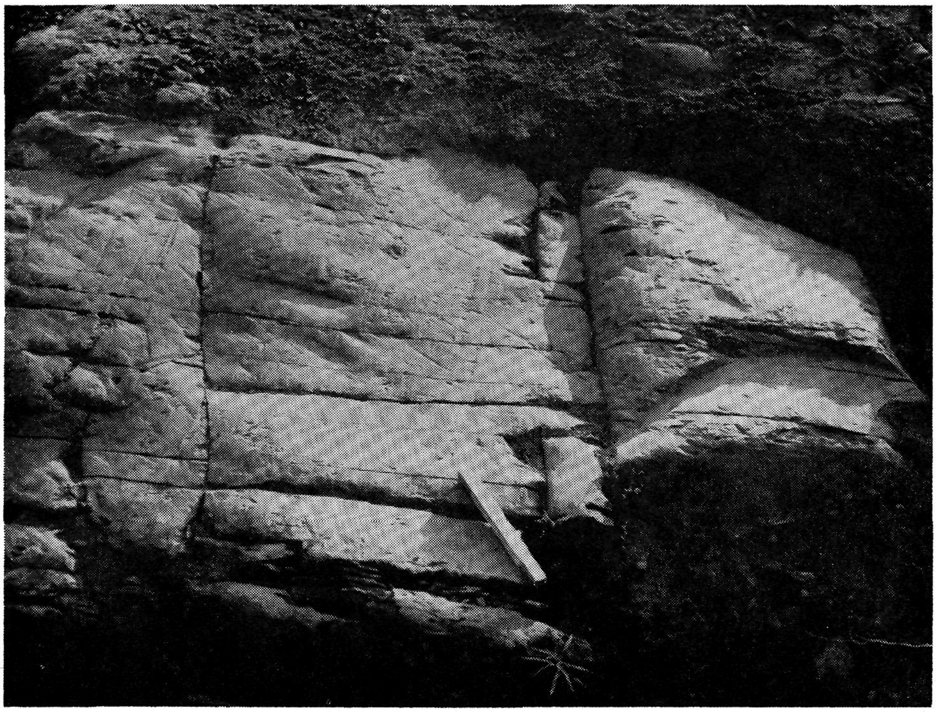
## Regional movements

Accepting the validity of local topographic control over at least late ice movements, the principal directions of ice movement at the centre of the peninsula may be explained in terms of an ice-dispersal centre or of an ice-remnant area. There still remains the broader pattern of ice movements over Labrador-Ungava as a whole, and to examine these even briefly required an appreciation of glacial events prior to those of the immediate deglaciation.

The Laurentide ice sheet may have originated on the high ground of Baffin Island to the north or within the Labrador-Ungava peninsula, either in valley glaciers in the highlands of the northeast, as suggested by Flint (1943 ; 1957), or along the Laurentian Scarp in the south, or by contemporaneous glacierization over all parts of the peninsula. Bird (1959) favors as original sites the upland surfaces of Baffin Island and northern Quebec, with rapid extension of a number of small ice-caps over the entire arctic mainland. Wherever the original site, the plateau of Labrador-Ungava was covered at maximum thickness by an ice sheet several thousand feet thick.

The factors controlling movement of ice within the ice sheet were the ground relief and the ice thickness. Considering first the effect of relief, the highest areas within the Labrador-Ungava peninsula are the upraised rim forming the Torngat Mountains in the northeast (5,200 ft.), the Mealy Mountains (3,800

FIGURE IV



Two contrasting sets of striations at Maryjo Lake near Schefferville. The rule is aligned north-south.

ft.) in the southeast, and the Otish Mountains (3,700 ft.) ; there is no field evidence for flow of ice downslope from any of these areas (Ives, 1957 ; Wheeler, 1958 ; Løken, 1960). Concerning ice thickness, the area of greatest snow accumulation at the present day is along or just south of the Laurentian Scarp (Barry, 1959) and if this were so at the time of glaciation, then the ice might be expected to have been thickest and outflow greatest from this area just to the north of the St. Lawrence River (Bird, 1959). But again, there is no sign of outflow from here ; and if there were outflow from any of the areas mentioned at any stage of glaciation, the movement was too weak to register or the visible evidence has been removed by subsequent movements.

The present radial pattern over Labrador-Ungava is thought by Bird (1959) to represent a change from a glacial-maximum centre of ice dispersal over southern Canada, and to indicate an outwards movement down the regional slopes from the high central part of the plateau. But the altitudinal contrasts and regional slopes over the Labrador plateau are not great ; and the outward movement from an ice-dispersal zone near Kivivic Lake is considered above to be a late-stage feature only. An explanation alternative to that of relief-controlled outward flow may therefore he suggested to explain the radial pattern.

The ice sheet in Labrador-Ungava was consumed both by thinning overall and by retreat of its margins. Although it is problematical how far the margine retreated before the ice became so thin that all effective regional movement ceased, in the east, for instance, it is considered that the ice-front retreated inwards from the coast right towards the final centre of wastage (Ives, 1959). As the margins came together, there would continue to be an induced movement of ice outwards normal to them, movement strong enough to produce a glacial-flow pattern, and penecontemporaneous with the acknowledged late-stage deposition of eskers. Both the glacial-flow pattern and the esker pattern to which it so closely corresponds would appear by this theory to be time-transgressive phenomena, being more recent at the centre of the peninsula than towards the margins. This concept regards Central Labrador-Ungava as an ice-divide in the sense of an ice-remnant rather than an ice-dispersal centre.

The situation in the northern part of the peninsula depends upon ice conditions in Ungava and Hudson Bays. In this quadrant the Glacial Map of Canada shows a pattern of glacial-flow features not radial from the centre of the peninsula but radial from Ungava Bay itself. The concept of radial retreat to the centre is therefore precluded for this quadrant. An ingress of marine waters into Ungava Bay might be expected to have increased the rate of deglaciation in this area, in the same way that the marine transgression into western Hudson Bay is thought to have encroached upon and speeded erosion of the margins of the Keewatin ice (Lee, 1959). Inland ice over Ungava Bay until relatively late in glacial times is postulated by Ives (1960*a*, 1960*b*) in order to explain the proglacial lakes in the George and Whale River valleys, and Bird (1960) comments also that Ungava Bay may conceivably be the site of the last ice residual from the Labrador ice sheet. That Hudson Strait and therefore Hudson Bay were covered by ice to a late stage of deglaciation is not consistent with the deglaciation in Keewatin where late-glacial marine transgression has been proved, although it is thought that the final stage in Labrador was somewhat earlier than the disappearance in Keewatin (Bird, 1959). Also the pattern radial into Ungava Bay may be gravity flow at a period later than that of the proglacial lakes.

Although the evidence presented in this paper as to direction of ice movement in the Labrador Trough around Schefferville may help to clarify the sequence of late ice movements here, earlier movements and the integration of all movements even within 50 miles of Schefferville is still inadequately pictured. In particular, insufficient is known of the relative ages of the centrasting ice movements to allow firm proposals for the complete chronology of events. Over the extensive areas where drift is dominant (Hare, 1959), a wide-ranging regional coverage of rapid till fabric orientation would be a valuable supplement to the present state of knowledge.

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## References cited


Barry, R. G. (1959), *A synoptic climatology for Labrador-Ungava*, in *McGill Sub-Arctic Research Papers*, No. 8, Montréal.

Bird, J. B. (1959), *Recent contributions to the physiography of Northern Canada*, in *Zeitsch. f. Geomorph.*, Vol. 3, pp. 151-74.

Bird, J. B. (1960), *The scenery of Central and Southern Arctic Canada*, in *Canadian Geog.*, No. 15, pp. 1-11.

Derbyshire, E. (1959), *Glacial drainage channels of the Schefferville-Goodwood area*, in *McGill Sub-Arctic Research Papers*, No. 6, pp. 34-38.

Douglas, M. C. V. & Drummond, R. N. (1953), *Glacial features of Ungava from air photographs*, in *Royal Soc. Can. Trans.*, Vol. 47, Ser. 3, sect. 4, pp. 11-16.

Flint, R. F. (1943), *Growth of the North American ice-sheet during the Wisconsin age*, in *Bull. Geol. Soc. Am.*, Vol. 54, pp. 325-62.

Flint, R. F. (1957), *Glacial and Pleistocene Geology*, Wiley.

Fox, D. J. (1958), *Morphology of the Elross Lake area, Quebec-Labrador*, in *Unpub. M. A. thesis*, Berkeley, Cal.

Grayson, J. F. (1956), *The postglacial history of vegetation and climate in the Labrador-Québec region as determined by palynology*, in *Unpub. Ph. D. thesis*, Univ. of Michigan.

Hare, F. K. (1959), *A photo-reconnaissance survey of Labrador-Ungava*, in *Geog. Branch, Mines & Tech. Surveys*, Memoir 6.

Harrison, J. M. (1952), *The Quebec-Labrador iron belt, Quebec and Newfoundland*, in *Geol. Sur. of Canada*, Paper 52-20.

Harrison, W. (1957*a*), *New technique for three-dimensional fabric analysis of till and englacial debris containing particles from 3 to 40 mm. in size*, in *Jour. Geol.*, Vol. 65, pp. 98-105.

Harrison, W. (1957*b*), *A clay till fabric : its character and origin*, in *Jour. Geol.*, Vol. 65, pp. 275-308.

Henderson, E. P. (1959), *A glacial study of Central Quebec-Labrador*, in *Geol. Sur. of Canada*, Bulletin 50.

Hoppe, G. (1959), *Glacial morphology and inland ice recession in Northern Sweden*, in *Geog. Annaler*, Vol. 41, pp. 193-212.

Lee, H. A. (1959), *Surficial geology of Southern District of Keewatin and the Keewatin Ice Divide, Northwest Territories*, in *Geol. Sur. of Canada*, Bulletin 51.

Lee, H. A., Craig, B. G. & Fyles, J. G. (1957), *Keewatin ice divide*, in *Bull. Geol. Soc. Am.*, Vol. 68, pp. 1760-61 (abstr.).

Ives, J. D. (1957), *Glaciation of the Torngat Mountains, Northern Labrador*, in *Arctic.*, Vol. 10, No. 2, pp. 66-87.

Ives, J. D. (1959), *Glacial drainage channels as indicators of late-glacial conditions in Labrador-Ungava : a discussion*, in *Cahiers de géographie de Québec*, No. 5, pp. 57-72.

Ives, J. D. (1960*a*), *The deglaciation of Labrador-Ungava — an outline*, in *Cahiers de géographie de Québec*, No. 8, pp. 323-43.

IVES, J. D. (1960*b*), *Former ice-dammed lakes and the deglaciation of the middle reaches of the George River, Labrador-Ungava,* in *Geog. Bull.,* No. 14, pp. 44-70.

IVES, J. D. (1960*c*), *Glaciation and deglaciation of Helluva Lake area, Central Labrador-Ungava,* in *Geog. Bull.,* No. 15, (in press).

KIRBY, R. P. (1961), *Deglaciation in Central Labrador-Ungava as interpreted from glacial deposits,* in *Geog. Bull.,* No. 16, (in press).

LØKEN, O. (1960), *Field work in the Torngat Mountains, Northern Labrador,* in *McGill Sub-Arctic Research Papers,* No. 9, pp. 62-74.

MANLEY, G. (1955), *A climatological survey of the retreat of the Laurentide Ice Sheet,* in *Am. Jour. Sci.,* Vol. 253, pp. 256-73.

SYME, A. M. (1951), *Glacial features in the vicinity of Knob Lake Labrador,* in *Unpub. M. Sc. thesis,* McGill Univ.

SHEELER, E. P. 2$^{nd}$ (1958), *Pleistocene glaciation in Northern Labrador,* in *Bull. Geol. Soc. Am.,* Vol. 69, 00. 343-44.

WILSON, J. T., *et al.* (1958), *Glacial Map of Canada,* in *Geol. Assn. of Canada.*