TILL PATTERNS IN CENTRAL LABRADOR [1]

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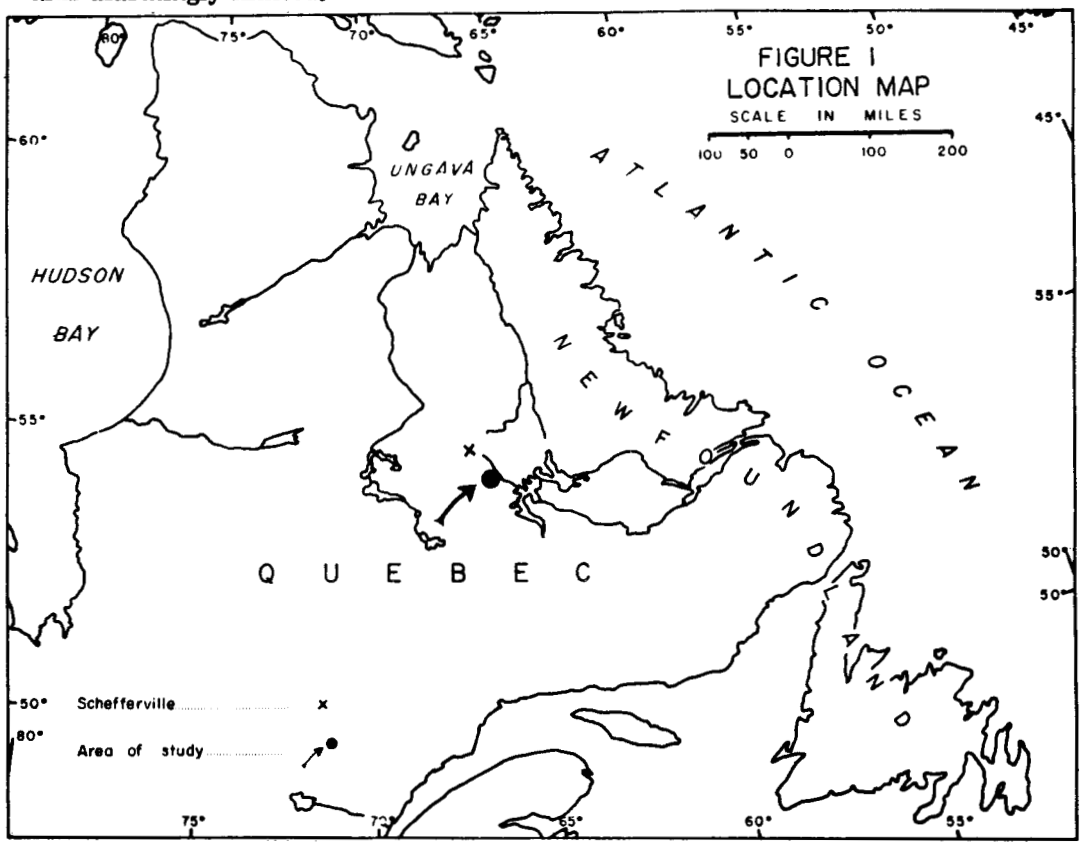
The development of new techniques and the increasing volume of work on late Wisconsin events in North America have resulted in a rapid advancement of our knowledge of the deglacierization of this continent, and such knowledge provides an invaluable basis upon which to assess the process of events further back in time. It is significant, however, that most of our knowledge is confined to the marginal areas of the Wisconsin ice sheets, and that knowledge of the so-called "centres of dispersal" remains alarmingly limited.



Labrador-Ungava has been regarded by many workers as one such area of ice dispersal, and one of the areas in which ice remained longest in late Wisconsin times. This hypothesis has recently been brought into sharper focus by the advent of large scale physiographic reconnaissance by the use of aerial photographs. Indeed, the

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[1] Presented at the Sixth Annual Meeting of the Canadian Association of Geographers, Montreal, 1956.

present investigation was prompted by the mapping of Labrador-Ungava from the air by the McGill research group under the direction of Dr. F.K. Hare.[1]

The establishment of the regional patterns of the drumlins and eskers has been particularly valuable. The plotted distribution has prompted the re-affirmation of the hypothesis that the central area of Labrador-Ungava was a major centre of ice dispersal, at least towards the close of Wisconsin times. It must be admitted, however, that such an interpretation of the complicated, rather than the simple, distribution of the glacial features, is by no means the only one possible. It was the purpose of the present work, carried out from the McGill Sub-Arctic Research Station at Knob Lake, to ascertain, if possible, the strength of such a hypothesis by detailed small scale investigation in the field.

In addition to the regional pattern of glacial deposits, a small scale pattern, of what will be called "rippled till" is strikingly apparent on some of the aerial photographs. One such area of patterned till is located 45 miles southeast of Knob Lake (Figure 1), and this area was examined in detail in an attempt to assess the composition and morphology of the rippled till and its relationship to the drumlins and eskers

Figure 2. General view of the "rippled till" country from the ridge of bedrock looking towards the northeast. Note the series of peninsulas, or ripples, in far distance and esker in centre.

[1] Hare, F.K.: "Mapping of Physiography and Vegetation in Labrador-Ungava. A Review of Reconnaissance Methods", The Canadian Geographer, 5, 1955, pp. 17-28.

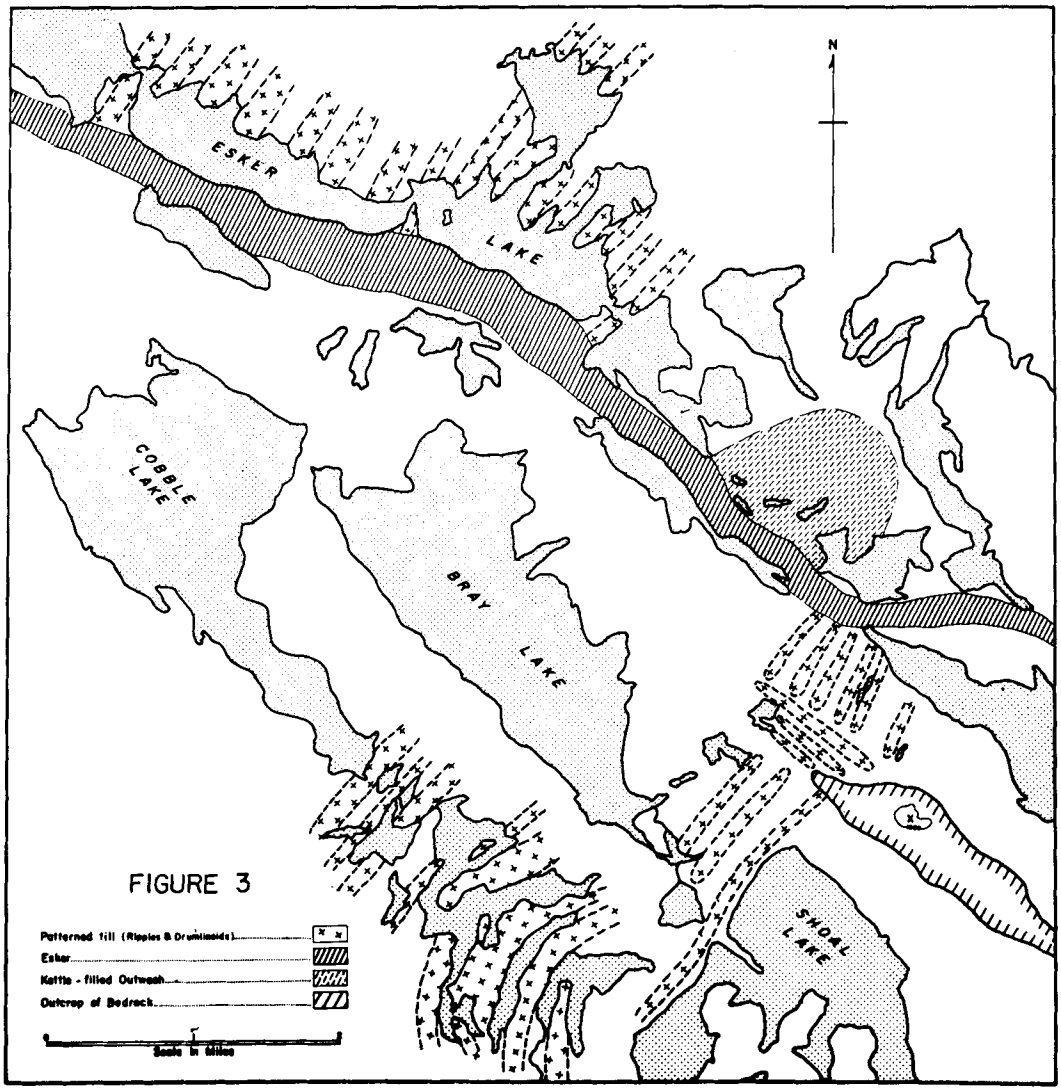

FIGURE 3

in the vicinity. To proceed from an examination of the small scale pattern to that of the overall regional pattern of the glacial deposits may assist an understanding of the final stages of the Wisconsin in that particular area.

The area examined lies to the east of Menihek Lake between Esker and Shoal lakes, and is drained by the upper waters of the Ashuanipi River. It lies within the area of the iron-bearing sedimentaries which has been called the "Labrador Trough" in which the structural trend runs northwest-southeast. The area may be described topographically as an undulating till plain with the local relief rarely exceeding 100 feet. The monotony of the plain is sharply broken, however, by a well developed esker - hence the name Esker Lake - which rises more than 150 feet above the surrounding country and follows a course sub-parallel to the regional drumlinoid trend. Occasional bedrock hills emerge above the apparently thick mantle of till to a height of more than 150 feet above the surrounding country. (Figure 2). The area is occupied

by a multitude of small lakes and forms part of that vast upland plateau which Tanner aptly called the "Lake Plateau".[1]

Over much of the area, and particularly northwest of Shoal Lake and along the northeast shore of Esker Lake, the gentle undulations of the till plain take on the remarkable regularity of sub-parallel ridges or "ripples" varying from 150 to 200 paces in width and displaying a general southwest to northeast alignment, perpendicular to that of the drumlins and eskers. The trend of the drumlins and eskers is taken to indicate the final direction of flow of Wisconsin ice. (See Figure 2).

From the air the pattern of land and water alone serves to bring out the rippled areas. Some of the best developed ripples form a series of 16 peninsulas along the northeast shore of Esker Lake.

The Esker Lake Ripples

Esker Lake is actually a series of three lakes and the narrows between each are localized by particularly well developed ripples. The ripples are best developed along the shore of the two northerly-most lakes, whereas the pattern becomes less distinct further south and finally merges into a weak drumlinoid trend.

The 16 peninsulas of Esker Lake are emphasized in the field by a prolongation of the dividing lake embayments in the form of bay-head marshes. Each ripple was examined and pits were dug at intervals of 10 paces perpendicular to the trend of the ripple, and supplementary pits were also dug along the ripple crests and in scattered places throughout the area.

The ripples vary in width between 150 and 200 paces and are separated by depressions of similar dimensions; in other words, the distance from crest to crest varies between one-sixth and one-quarter of a mile. The maximum relief of the crest above the floor of the embayment was measured as 50 feet, although in places this was as little as 20 feet; lengthwise the ripples remained distinct for up to half a mile. Except for small wave-cut cliffs, the contours were smoothly flowing and no abrupt breaks of slopes were observed. (Figure 4).

The numerous pits, dug to depths of up to 10 feet, but generally not exceeding four feet, revealed that the ripples were composed predominantly of medium to coarse grained sand. Pebbles were observed in very few places and no preferred orientation of their long axes could be determined. The upper part of many of the sections showed a thin cover of coarser material ranging up to six feet in diameter, but generally not exceeding 12 inches. This material was composed predominantly of local rock, quartzite, dolomite and ironstone, although occasional pieces of granite-gneiss were found. The material was angular to sub-angular, and striations were occasionally well preserved on blocks of dolomite. This cover was quite irregular, and in many places was entirely lacking. It is interpreted as ablation moraine and appears to bear no relation to the morphology of the rippled pattern.

The result of this digging has led to the conclusion that the entire area is composed of medium to coarse grained sand with a very small proportion of coarser material, most of which is confined to the surface. The inadequacy of the exposures revealed by digging, and the difficulty of discovering any coarse sorting by this method are recognized.

South Esker Lake

This area is interesting because here the ripples gradually merge into a weakly developed drumlinoid trend. No clear-cut contact was observed although the composition of the drumlinized ground was essentially similar to that further north.

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[1] Tanner, V.: Outlines of the Geography, Life and Customs of Newfoundland-Labrador, Helsingfors, 1944, pp. 61-62, and Figure 18.

Figure 4. The Esker Lake Ripples. View towards the northeast across the crest of the esker. Bedrock hills on the horizon.

Southwards again the land rises and the drumlinoids in turn are masked by a complicated development of the esker - a large tract of kettle-filled sand which appears to have been deposited at a later date than the drumlinoids. However, this age differential is difficult to ascertain owing to the similarity of the constituent material of the two topographic forms.

Finally, in the Esker Lake area, a wave-cut cliff in the side of a ripple provided the only natural exposure which was discovered. When the slump material had been cleared away, a good vertical section 12 feet deep was exposed. The top three feet was in medium to coarse grained sand. This overlay, with a gently irregular contact, medium grained sand which continued to the base of the section. Five horizontal partings of coarse grained sand were observed in the lower part of the section, while throughout were scattered iron-stained concretions which were presumeably of a secondary nature.

This was the only instance where any sign of stratification was observed in the area.

Another important point about this particular ripple is that it merged directly into the esker, meeting it at right angles. As the esker was approached a gradual increase in the coarseness of the material was observed, particularly in the surface material. The esker, while composed predominantly of sand, contained a high proportion of material between gravel and cobble grain size.

Till Patterns Between Esker Lake and Shoal Lake

The area between Esker Lake and Shoal Lake displays a strongly developed pattern of rippled till, with much of the area between the ripples occupied by small lakes elongated southwest to northeast. This pattern extends along the southeast shore of Bray Lake, where, however, the relief becomes less marked and the inter-crest areas are largely marsh-filled. (Figure 5). As the thickness of the till diminishes,

Figure 5. View from the crest of one ripple looking towards the next. Here the intervening depression is partially filled with lake and marsh.

the whole pattern gradually fades out on the northwest shoulder of a ridge of bedrock. Along the northeast flank of this ridge three distinct drumlinoids occur with a maximum relief of 15 feet. Northwest of the drumlinoids there is an abrupt change in the alignment of the till with the northeast to southwest ripple trend again prodominating. The whole area between the drumlinoids and the esker, about a mile across, is characterized by a complex distribution of ridges and kettles with small elongated areas of marsh or lake between the ridges. At their southwestern extremity the ridges have the same appearance as the ripples already described, but towards the esker they become narrower and higher until they resemble small eskers. (Figure 6). Three such ridges were particularly well developed, and but for a small col beneath the flank of the esker, they gradually increased in height until they ran into the esker at right angles. As in the instance described above, the proportion of pebbles and gravel to sand increased as the esker was approached.

Figure 6. As the esker is approached the broad ridges become narrower and steeper and have the appearance of a small esker.

Scattered pits dug throughout the entire area revealed the same results as in the vicinity of Esker Lake - a non-sorted sand capped by an irregular cover of ablation moraine.

It would be interesting, in fact necessary, before any further progress could be made with this problem, to obtain knowledge of the till composition between the ripples. Exposures were unobtainable owing to the presence of lake water or a considerable depth of marsh. Until more evidence is available it will be assumed that the entire area is composed of a large proportion of medium to coarse grained sand.

Origin of the Rippled Till

Features which are superficially similar to those described above, and which may be generically related to them, have been found to occur in southern Scandinavia,[1] on the Canadian Plains, and in various other parts of the Canadian Shield.[2]

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[1] De Geer, G.: "Geochronologica Suecica Principles", K. Svenska Vetenskapasakad Handl, Ser.3, 18, 1940, pp.125-130.

[2] Mawdsley, J.B.: "Washboard Moraines of the Opawica-Chibaugamau District". Trans. Roy. Soc. Can. Ser.3, 30, 1936, pp.9-12.

Hypotheses put forward to explain such till patterns may be grouped under two headings. The first hypothesis can be related to Tanner who believed that such patterns were typical of "dead ice topography" and were caused by material being washed into crevasses in stagnant ice which were being widened and enlarged during progressive ablation.[1] This hypothesis encounters difficulties when the composition of the till, the strikingly regular form and the even spacing are considered. Also the ridges are as wide as the troughs, a characteristic which is difficult to relate to stagnant ice.

The regularity of the ripples has led other workers to associate them with annual recessional moraines.[2] In this connection mention must be made of a recent paper by Elson who describes what appears to be related features on the Canadian Plains and which he calls "washboard moraines". These he associates with an annual cycle of recession.[3]

The ripples in central Labrador-Ungava occur at intervals of one-sixth to one-quarter of a mile, which provides a reasonable order of magnitude for the annual recession of an ice lobe. However, given an annual ablation rate of as much as 30 feet, this would provide a surface slope of only two and one-half degrees for the ice lobe. Furthermore, when the significance of what is certainly "dead ice topography" and marginal drainage channels, found some tens of miles further north, is considered, it appears that down-wasting rather than marginal retreat was characteristic of the final stages of the deglacierization in this area. This would scarcely allow the formation of regularly spaced terminal moraines of considerable size. Indeed, as stated by Flint, the concept of marginal retreat has been somewhat overstressed; this seems particularly true when applied to the final stages of the Wisconsin.

From the evidence presented above it appears that neither hypothesis is completely satisfactory. The ripples, so closely associated with the esker, were probably formed contemporaneously with it. It is considered that much more field work will be required, and that deep drilling in particular might obtain more relevant information.

The Final Stages of the Wisconsin in Central Labrador-Ungava

Another method of approach is a general consideration of the glacial geomorphology of the entire Knob Lake area. Only a few references can be made to this here and a paper in preparation deals with this topic more fully. As mentioned above, the radiating pattern of the drumlins and eskers about the Knob Lake area has been taken to suggest that central Labrador-Ungava was one of the centres of glacial outflow.[4,5,6] Semi-permanent snowbanks in the area were examined and firn pits revealed a minimum of possibly three years' accumulation. This, together with the 25-inch isohyet,

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[1] Tanner, V.: op. cit., p. 209, and Figure 108.

[2] Syme, A.M.: Glacial Features in the Vicinity of Knob Lake, Labrador, Unpublished M. Sc. Thesis presented to McGill University, 1951, pp. 23-24.

[3] Elson, J.A.: "Periodicity of Deglaciation in North America. Part II, Late Wisconsin Recession", Geog. Annaler, 2, 1953, pp. 95-104.

[4] Low, A.P.: Geological Survey of Canada, Ann. Rep., VIII, Ottawa, 1896, pp. 1L-387L.

[5] Odell, N.E.: "The Geology and Physiography of Northernmost Labrador", In Northernmost Labrador Mapped from the Air, by A. Forbes, New York, American Geographical Society, 1938, p. 206.

[6] Tanner, V.: op. cit., pp. 174-177.

which encircles the area, may be used as further evidence to suggest that even today the area approximates a condition of glaciation, and therefore it seems reasonable to assume that some of the final remnants of the Wisconsin ice were situated in this area. This is borne out by the field evidence which includes marginal drainage channels, overflow channels and glacial lake shorelines. To assume from this evidence that the Knob Lake area was the centre of ice dispersal is fallaceous and is based upon the dangerous assumption that conditions towards the close of Wisconsin times were relatively similar to those prevailing at an earlier period.

Field evidence, in the form of glacial striations, chatter marks, roches moutonnées, and erratic blocks, indicate that the last regional movement of ice, at least within a 50-mile radius of Knob Lake, was from the northwest or north-northwest towards the south. No evidence of local movement later than this was observed strengthening the hypothesis that the final disintegration was characterized by stagnation and down-wasting. However, two older sets of striations were discovered, one bearing north-northeast to south-southwest and the other east to west, and emphasize the complexities of the problem and the widely changing conditions during the last glacial period.

The present state of our knowledge allows no definite interpretation of either the rippled till, the small scale pattern, or the drumlin and esker trends, the large scale pattern. However, the purpose of this work will have been achieved if it has brought into open discussion the problem of the interpretation of the till patterns, and if it has emphasized the need for detailed field studies nearer the possible centres of glaciation.