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Géographie physique et Quaternaire, vol. 38, n° 1, 1984, p. 75-80.

Géographie physique et Quaternaire, 1984, vol. XXXVIII, n° 1, p. 75-80, 9 fig.

GLACIAL LAKE IN THE RICHARDSON AND RAE RIVER BASINS, NORTHWEST TERRITORIES

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ABSTRACT Systematic mapping of the surficial deposits in the Richardson River basin, south and west of Coppermine, District of Mackenzie, N.W.T. has yielded strong evidence for the former existence of a glacial lake. A sequence of glacial lakes occupied an extensive portion of the basins drained by the Richardson and Rae rivers. Water bodies were trapped in this large depression to the west of Coronation Gulf by easterly retreating glacier ice. Four lake phases are recognized, each controlled by progressively lower outlets at 330 m, 260 m, 235 m and 165 m a.s.l. It is proposed that the lake which finally drained in a postglacial sea be called Glacial Lake Richardson. The former presence of the glacial lake and the associated deltas and outlets are essential elements in reconstructing the deglaciation history of the area.

RÉSUMÉ *Un lac glaciaire dans les bassins des rivières Richardson et Rae, Territoires-du-Nord-Ouest*. La cartographie systématique des dépôts meubles du bassin de la rivière Richardson a permis de reconnaître l'existence d'au moins un lac glaciaire d'importance dans la région. Au cours de différentes phases, le lac glaciaire a occupé une partie ou une autre de la dépression topographique formée par les bassins des rivières Rae et Richardson, à l'ouest du golfe du Couronnement. Quatre phases distinctes ont été reconnues, chacune ayant été contrôlée par des exutoires à 330 m, 260 m, 235 m et 165 m a.n.m. On propose de nommer ce lac, qui s'est drainé dans la mer post-glaciaire, «Lac glaciaire Richardson». L'identification des différentes phases du lac glaciaire a grandement facilité la détermination des modalités de la déglaciation dans la région du bassin de la rivière Richardson.

INTRODUCTION

Systematic mapping of glaciolacustrine rhythmites and deltas confirm the existence of a glacial lake in the Richardson and Rae river basins (Fig. 1). In this study the former extent of this glacial lake is defined for the first time and its use in defining former positions of the retreating ice front is assessed.

EVIDENCE FOR A GLACIAL LAKE

GLACIOLACUSTRINE DEPOSITS

Along the Richardson River, thick sequences of up to 5 m of glaciolacustrine rhythmites are exposed (Fig. 2). These varves, although limited to the western half of the Richardson River basin (Fig. 1), are found on the surface between 135 m and 220 m a.s.l. Below 135 m, they are covered by massive marine clays, varying in thickness from 40 cm, at their westernmost location, to 15 m at the mouth of the Richardson River. Because the varves are topped in part by marine deposits and since they also occur at higher altitudes than the recorded marine limit in the area at approximately 170 m (CRAIG, 1960; ST-ONGE and BRUNEAU, 1982) it follows that their formation preceded the marine transgression in the area.

Each varve is composed of two distinct layers. The average 6 cm thick summer layer consists of greyish silty clays showing an internal stratification. An occasional layer of pebbles less than 2 cm thick is present within some summer layers. In turn, the average 4 cm thick brownish winter layer is composed of massive clay. This particular varve composition is characteristic of the northern part of the basin. To the south, the silty clay summer layers are much coarser and the varves are thicker. In general, the thickness of the clayey winter layers increases southward from 3 to 20 cm, and that of the summer layers from 5 cm to 2 m.

DELTAS

Four distinct fan shaped accumulations (Fig. 1, location A, B, C, and D) composed of cobbles, pebbles and coarse sand are found to be resting at about 260 m a.s.l. against the northern edge of the plateau, south of the Richardson River (Fig. 1). The surface of these deposits is flat, incised by channels and bounded on one end by a steep edge. These landforms are interpreted as being deltas (Fig. 3). Given their relatively high altitude, it is clear that these deltas were formed in a water body other than the postglacial sea which did not reach an altitude greater than 170 m in the area (ST-ONGE and BRUNEAU, 1982). Also identified, north of the Richardson River, is a similar deposit located at the southern end of Libby Lake (Fig. 1, location G), at an altitude of 250 m a.s.l.

Seven other deltas are recognized east of Melville Hills. Some are thought to have been built in the water body which flooded the Rae and Richardson basins (Fig. 1, location M, N and O), while others are likely related to other postglacial water bodies (Fig. 1, location I, J, K, and L).

OUTLETS

Extending beyond the study area, a number of deeply incised meltwater channels served as glacial lake outlets.

North-west of the Richardson River basin at 330 m a.s.l. (Fig. 1, location H) a 40 m deep and 10 km long channel (Fig. 4) cut in clayey till is present. The water likely drained

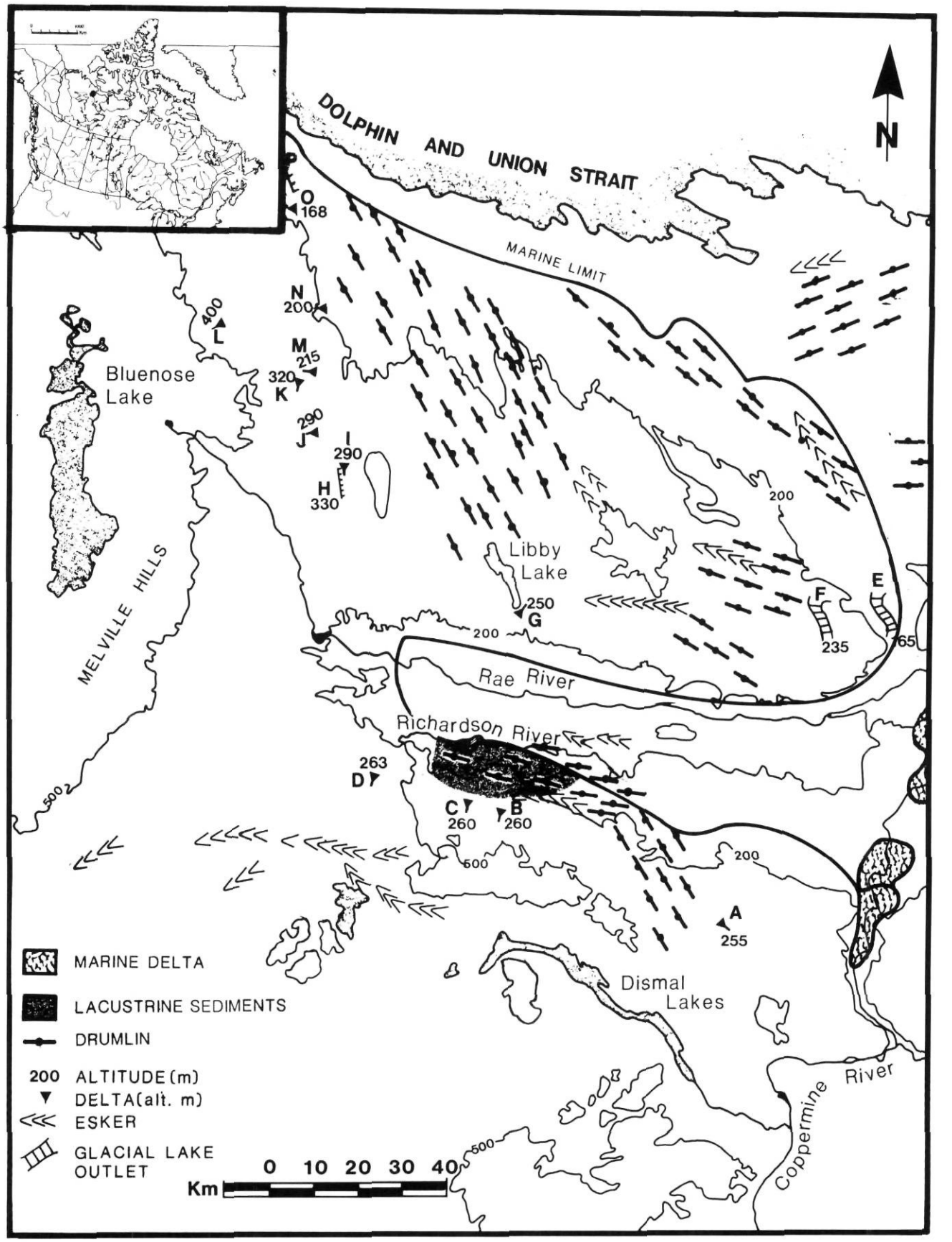

FIGURE 1. Location map and morphological data. *Carte de localisation et données géomorphologiques.*

along the ice front, eroding the till blanket and gradually lowering the lake level.

East and north of the Rae River (Fig. 1, location F) a 10 km long and 60 m wide channel cut in bedrock and oriented NNW-SSE, is found at an altitude of 235 m a.s.l. (Fig. 5). Just 15 km east (Fig. 1, location E) is another similar channel 9 km long, 80 m wide and 40 m deep this one at an altitude of 165 m a.s.l. Both of these channels were also likely used as outlets.

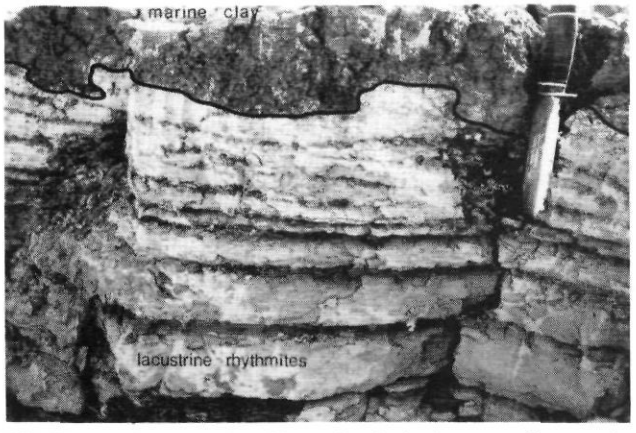

FIGURE 2. Upper section of lacustrine rhythmites topped by massive marine clays, along the Richardson River. Scale = 21 cm.

Partie supérieure d'une séquence de rythmites lacustres recouvertes d'argiles marines exposées le long de la rivière Richardson. Échelle = 21 cm.

INTERPRETATION

Based on the data presented above, it is thought that the glacial lake that occupied the depression formed by the basins of the Rae and Richardson rivers was controlled by four successively lower outlets which define four lake phases. We propose to name the water body "Glacial Lake Richardson".

PHASE 1

Initially, Glacial Lake Richardson was formed when meltwater was trapped between the highlands west of Coronation Gulf (Fig. 6) and the eastwardly retreating ice front.

This first phase was controlled by an outlet situated to the north-west of the Richardson River basin (Fig. 6, location H) as witnessed by a one sided meltwater channel at 330 m a.s.l. (Fig. 4). The ice front forming the east side of this channel was in place long enough to allow the formation of a stable water level at that altitude. This water body covered a maximum area of 1,350 km^2 in the western part of the Rae River basin.

A delta at the northern end of the channel (Fig. 6, location I) indicates that the sediment laden water ended its course in another glacial lake at 290 m a.s.l. (Fig. 6). The evidence for this water body is further supported by a second delta at that altitude (Fig. 1, location J) 25 km north-west of the first and resting against the Melville Hills (Fig. 1). This small 300 km^2 glacial lake at 290 m a.s.l. is the last of a series of glacial lakes that occupied the depression between the retreating ice front and the Melville Hills as witnessed by higher deltas (Fig. 1, location K and L). Unfortunately, the reconstruction of this sequence of glacial lakes is beyond the scope of this paper and will not be discussed in more detail.

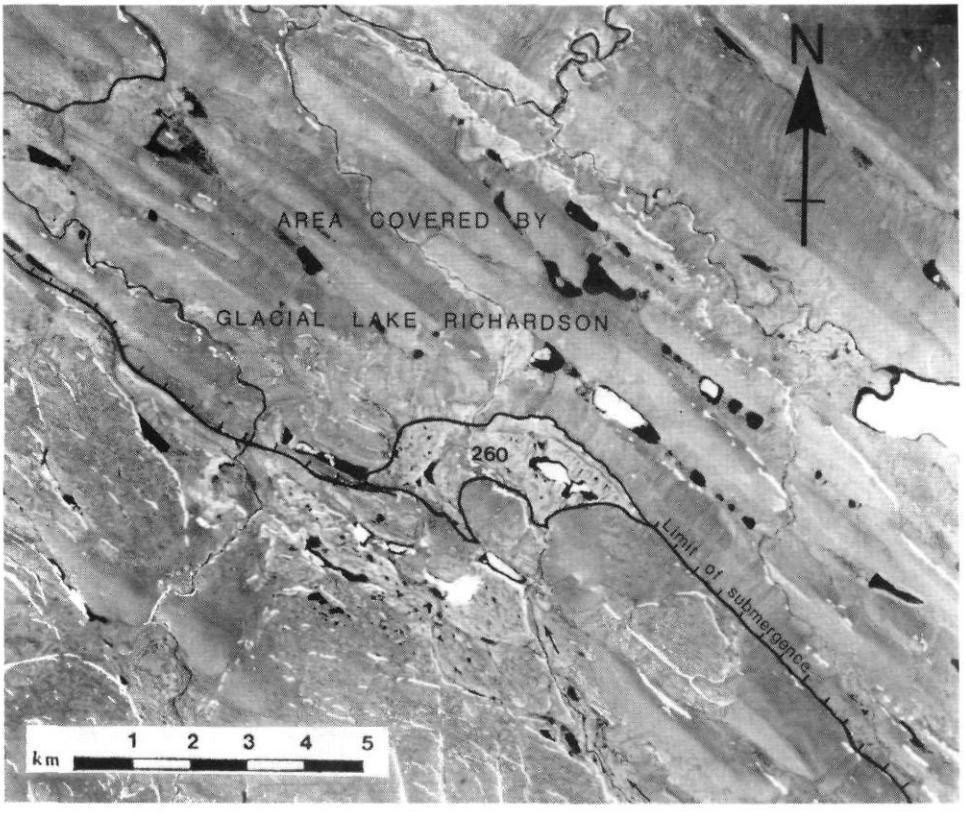

FIGURE 3. Location B: section along the south shore of Glacial Lake Richardson Basin showing a delta at 260 m a.s.l. and the limit of lacustrine submergence. Part of air photograph A13610-144, E.M.R.

Site B: rive sud du bassin du lac glaciaire Richardson montrant un delta à 260 m a.n.m. et la limite de submersion lacustre. Partie de la photographie aérienne n° A13610-144, E.M.R.

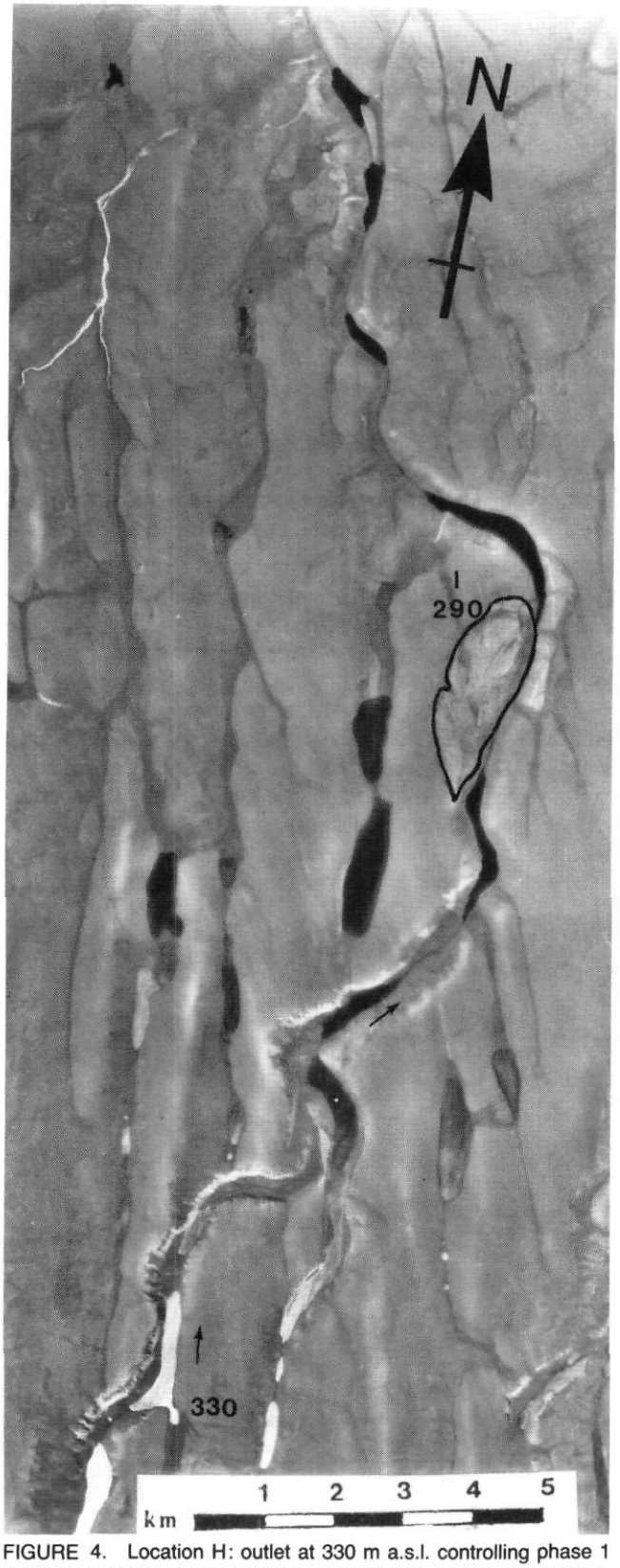

FIGURE 4. Location H: outlet at 330 m a.s.l. controlling phase 1 of Glacial Lake Richardson with a delta at 290 m a.s.l. (Location I) constructed into a small ice marginal lake. Part of air photograph A24224-172, E.M.R.

Site H: exutoire à 330 m a.n.m. régularisant le lac glaciaire Richardson pendant la phase 1 et un delta à 290 m a.n.m. (site I) construit dans un petit lac glaciaire. Partie de la photographie aérienne n° A24224

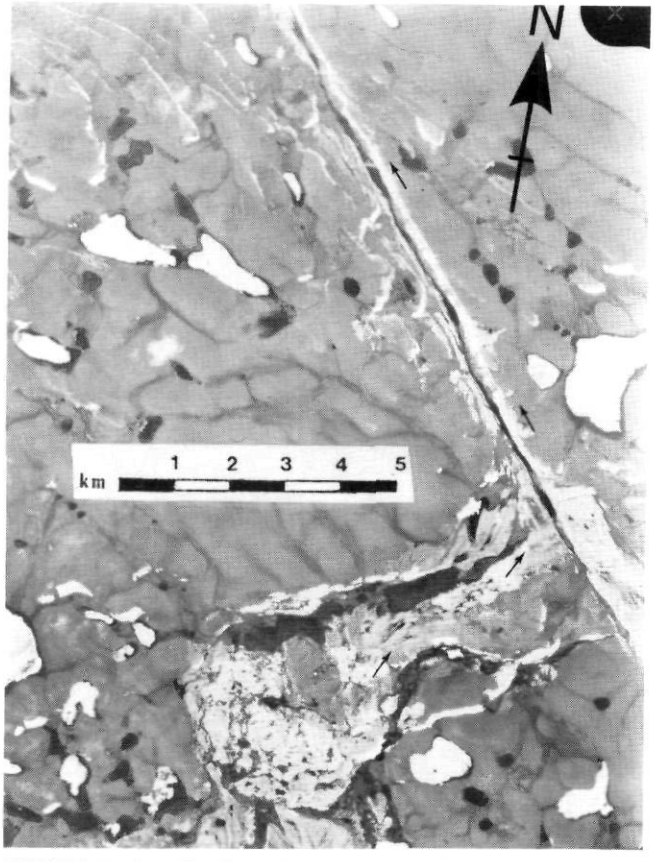

FIGURE 5. Location F: outlet at 235 m a.s.l. controlling phase 3 of Glacial Lake Richardson. Part of air photograph A22435-106, E.M.R.

Site F: exutoire à 235 m a.n.m. régularisant le lac glaciaire Richardson au cours de la phase 3. Partie de la photographie aérienne n° A22435-106, E.M.R.

Further eastward retreat of the ice front permitted rapid drainage of the glacial lake at 330 m a.s.l., which then stabilized at approximately 260 m a.s.l. when a lower outlet was opened.

PHASE 2

As suggested by the numerous deltas (Figs. 1, 3 and 7), in and around the Richardson River basin, a water body flooded extensive areas up to 260 m a.s.l. At that time, Glacial Lake Richardson extended over a minimum area of 6,400 km^2 and drained into the sea to the north-west between the ice front and the Melville Hills (Fig. 7). Although a precise outlet has not been located, it is likely the water was evacuated along the downhill retreating ice front thus permitting a progressive lowering of the lake level.

PHASE 3

When another outlet at 235 m a.s.l. (Figs. 5 and 8) to the north-east of the Richardson River basin was freed of ice, another phase of Glacial Lake Richardson was initiated. The outlet, which was previously used as a meltwater channel drained the lake which now covered an area of 4,600 km^2. During this phase, lake levels were lowered as the sediment filled outlet was progressively incised. Glacial Lake Richardson

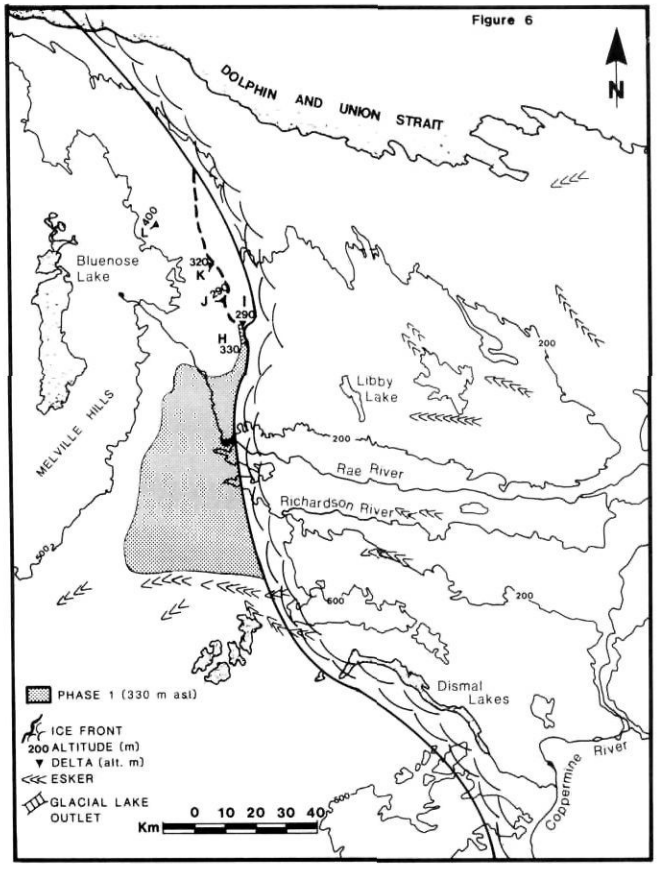

FIGURE 6. Phase 1 of Glacial Lake Richardson.

La phase 1 du lac glaciaire Richardson.

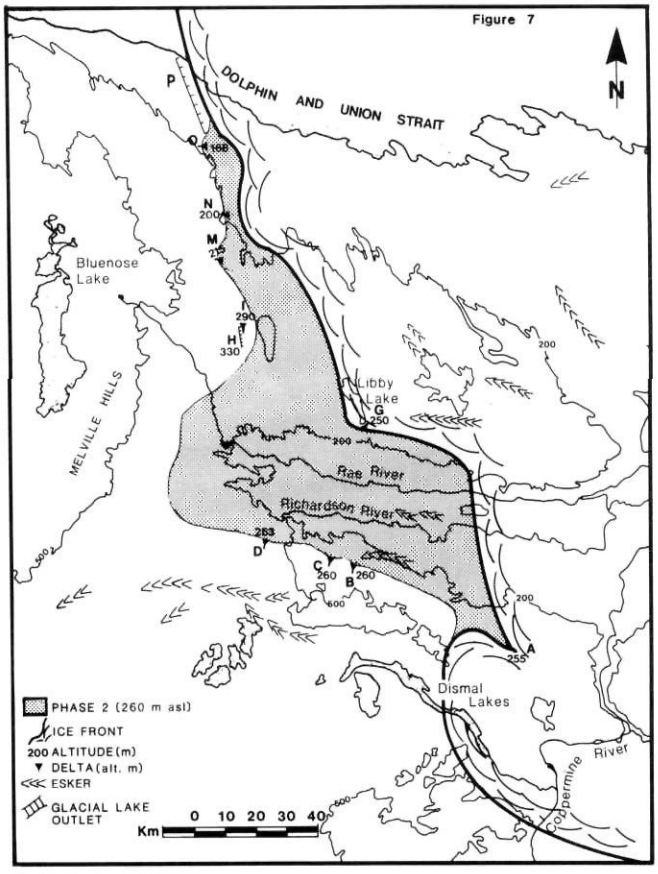

FIGURE 7. Phase 2 of Glacial Lake Richardson.

La phase 2 du lac glaciaire Richardson.

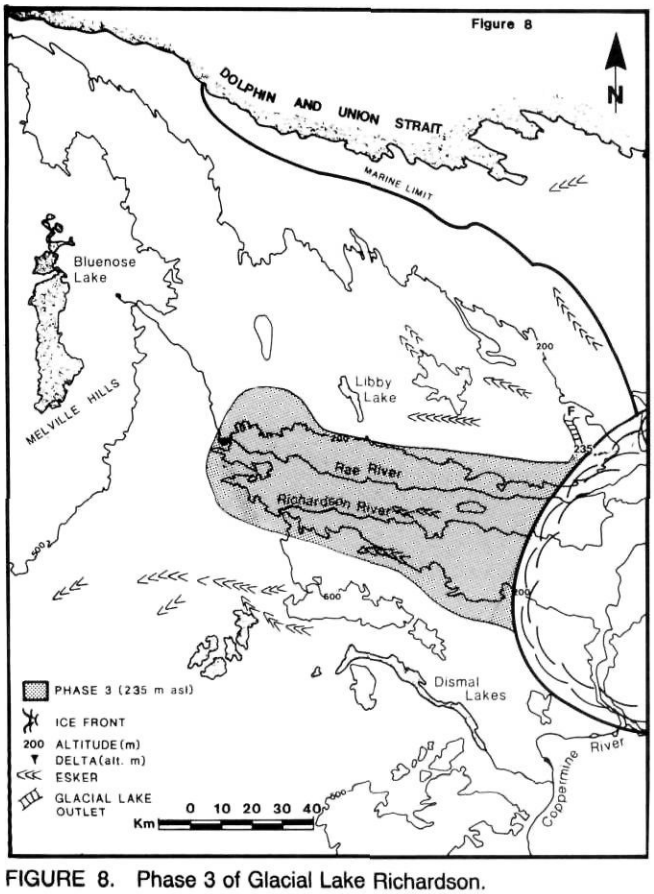

FIGURE 8. Phase 3 of Glacial Lake Richardson.

La phase 3 du lac glaciaire Richardson.

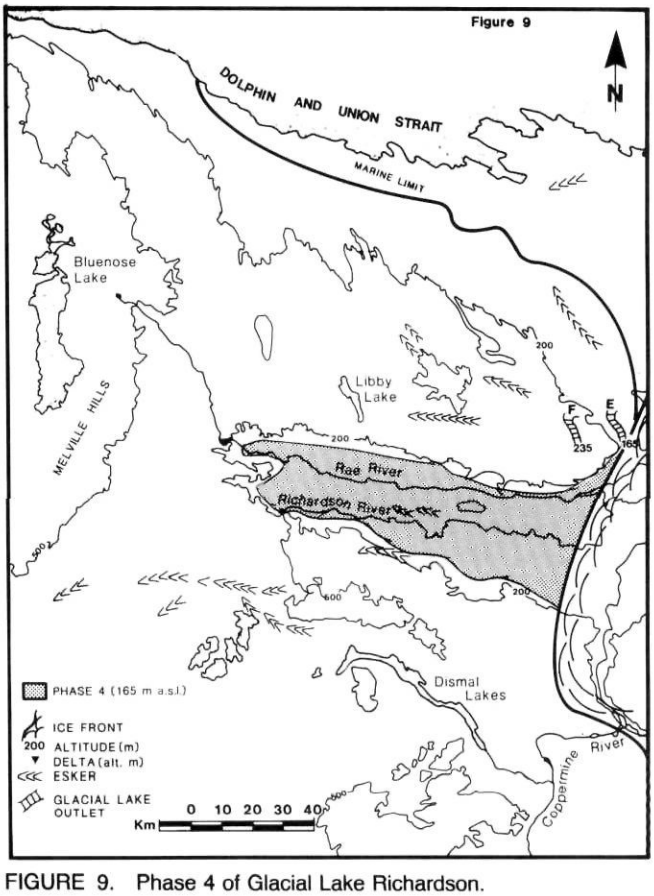

FIGURE 9. Phase 4 of Glacial Lake Richardson.

La phase 4 du lac glaciaire Richardson.

then drained through a lower outlet which opened following a 15 km eastward retreat of the ice front.

PHASE 4

The final phase of the lake came about when a 165 m a.s.l. outlet, located north-east of the Richardson River basin, was freed of ice (Figs. 1 and 9, location E). During this phase, the lake extended over an area of 3,200 km^2 (Fig. 9).

Shortly after, the ice front retreated still further east and eventually permitted the incursion of the sea, which marked the end of Glacial Lake Richardson. This event is known to have occurred before 10,300 ± 240 years ago (GSC-3663), since marine shells *(Macoma calcarea)* collected on a raised beach at 122 m a.s.l. in the Richardson River basin provided that age.

CONCLUSION

Since few glacial features indicate ice marginal positions in the area, we must rely on alternate sources of evidence in defining the succession of ice fronts during deglaciation. For that purpose, the identification of the various phases of a glacial lake in the Rae and Richardson River basins was of particular interest. From the data collected, four retreating positions of the ice front were determined in order to account for the phases of Glacial Lake Richardson. As of yet, no evidence can provide information on the age of the phases concerned. Nevertheless, a varve count establishes a minimum duration of 120 years for the existence of Glacial Lake Richardson.

ACKNOWLEDGEMENTS

This study, part of an ongoing M.A. thesis at the Department of Geography, University of Ottawa, was made possible because of the following grants: a University of Ottawa Northern Research Grant to the author, an NSERC (A 8026) grant and a Department of Indian and Northern Affairs research agreement to Dr. D.A. St-Onge. Logistic help from DIAND and EMR is also gratefully acknowledged. The original manuscript was greatly improved by comments by Drs. D.A. St-Onge and J.-S. Vincent to whom very sincere thanks are extended. We also thank Dr. M. Bouchard and Ms. L. Savoie for reviewing the manuscript.

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