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Résumé de l'article

Plus de 70 nouvelles datations au radiocarbone effectuées sur d'anciens niveaux marins, sur la terre de Hall (nord-ouest du Groenland) et dans la baie de Clements Markham (nord de l'île d'Ellesmere), ont été associées aux données déjà recueillies et permettent de réviser les isobases de la région. Celles-ci révèlent: 1) un centre d'émersion postglaciaire maximale au nord-ouest du Groenland qui s'étend jusqu'à 2) un compartiment de faible relèvement dans le nord-est de l'île d'Ellesmere, couvert par l'inlandsis du Groenland qui s'étendait jusqu'à 3) un centre d'émersion plus importante à l'endroit des Grant Land Mountains, à l'extrême nord de l'île d'Ellesmere, associée à révolution des calottes glaciaires locales. La datation au radiocarbone de lignes de rivage soulevées révèle un décalage de 2000 ans entre le retrait glaciaire qu'a connu l'extrême nord d'Ellesmere et celui qu'a connu le nord-ouest du Groenland. Ce décalage entre les rajustements glacioisostatiques laisse entrevoir une grande variation dans le temps de réaction du glacier et dans les régimes glacioclimatiques de la région. Partout la dernière limite glaciaire se situe de 40 à 60 km au-delà des marges glaciaires actuelles. L'émersion maximale près de cette limite est marquée par des lignes de rivage construites en pleine mer glaciaire, qui vont de 124 m anm, dans la baie de Clements Markham, à 150 m anm, sur la terre de Hall. Ceci révèle qu'ailleurs une emersion de cet ordre, soit de 120 à 150 m, ne suppose pas nécessairement le retrait de toute la calotte glaciaire, bien que cette idée soit généralement acceptée. Les conséquences géophysiques qui en découlent exigent désormais qu'on en tienne compte.

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POSTGLACIAL ISOBASES FROM NORTHERN ELLESMERE ISLAND AND GREENLAND: NEW DATA

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ABSTRACT Over seventy new ^{14}C dates on former relative sea levels from Hall Land, northwest Greenland, and Clements Markham Inlet, northern Ellesmere Island, are combined with previous data to revise the regional isobases for this area. These isobases show: 1) a centre of maximum postglacial emergence over northwest Greenland extending to; 2) an intervening cell of lower emergence over northeast Ellesmere Island which was isostatically-dominated by the Greenland Ice Sheet; in turn, extending to 3) a higher centre of emergence over the Grant Land Mountains, northernmost Ellesmere Island, associated with the independent history of local ice caps there. Radiocarbon dates from raised marine shorelines show a 2000 year lag between glacial unloading on northwest Greenland and northernmost Ellesmere Island. This lag in glacioisostatic adjustments suggests a considerable range in the glacier response times and/or glacioclimatic regimes in this area. Throughout the area the last ice limit was *ca.* 5-60 km beyond present ice margins. Maximum emergence at these ice limits is marked by shorelines built into a full glacial sea which range from 124 m asl in Clements Markham Inlet to 150 m asl in Hall Land. This indicates that similar emergence (120-150 m) in other areas does not necessarily require the removal of entire ice sheets although this has been commonly assumed in the literature. The geophysical implications of this warrant consideration.

RÉSUMÉ *Isobases postglaciaires du nord de l'île d'Ellesmere et du Groenland: nouvelles données.* Plus de 70 nouvelles datations au radiocarbone effectuées sur d'anciens niveaux marins, sur la terre de Hall (nord-ouest du Groenland) et dans la baie de Clements Markham (nord de l'île d'Ellesmere), ont été associées aux données déjà recueillies et permettent de réviser les isobases de la région. Celles-ci révèlent: 1) un centre d'émersion postglaciaire maximale au nord-ouest du Groenland qui s'étend jusqu'à 2) un compartiment de faible relèvement dans le nord-est de l'île d'Ellesmere, couvert par l'inlandsis du Groenland qui s'étendait jusqu'à 3) un centre d'émersion plus importante à l'endroit des Grant Land Mountains, à l'extrême nord de l'île d'Ellesmere, associée à l'évolution des calottes glaciaires locales. La datation au radiocarbone de lignes de rivage soulevées révèle un décalage de 2000 ans entre le retrait glaciaire qu'a connu l'extrême nord d'Ellesmere et celui qu'a connu le nord-ouest du Groenland. Ce décalage entre les rajustements glacioisostatiques laisse entrevoir une grande variation dans le temps de réaction du glacier et dans les régimes glacioclimatiques de la région. Partout la dernière limite glaciaire se situe de 40 à 60 km au-delà des marges glaciaires actuelles. L'émersion maximale près de cette limite est marquée par des lignes de rivage construites en pleine mer glaciaire, qui vont de 124 m anm, dans la baie de Clements Markham, à 150 m anm, sur la terre de Hall. Ceci révèle qu'ailleurs une émersion de cet ordre, soit de 120 à 150 m, ne suppose pas nécessairement le retrait de toute la calotte glaciaire, bien que cette idée soit généralement acceptée. Les conséquences géophysiques qui en découlent exigent désormais qu'on en tienne compte.

AUSAMMENFASSUNG *Postglaziale Isobasen vom Norden der Ellesmere-Insel und Grönland: neue Daten.* Über 70 neue ^{14}C Daten über frühere relative Meeresspiegel von Hall Land, Nordwest-Grönland und der Clements Markham Bucht, nördliche Ellesmere-Insel, werden mit schon vorhandenen Daten kombiniert, um die regionalen Isobasen für dieses Gebiet zu revidieren. Diese Isobasen zeigen: 1) ein Zentrum des maximalen postglazialen Auftauchens über Nordwest-Grönland, welches sich ausdehnt zu 2) einem dazwischenliegenden Geländeabschnitt mit niedrigerem Auftauchen über dem Nordosten der Ellesmere-Insel, welcher isostatisch durch die Grönland Eiskappe dominiert wurde; welcher seinerseits sich zu 3) einem höheren Auftauchzentrum über den Grant Land Mountains ausdehnte, im äußersten Norden der Ellesmere-Insel, das mit der unabhängigen Geschichte der dortigen lokalen Eiskappen in Verbindung gebracht wird. Radiokarbon-Daten der gehobenen marinen Küstenlinien zeigen einen Zeitunterschied von 2000 Jahren zwischen dem glazialen Rückzug im Nordwesten von Grönland und dem im äußersten Norden der Ellesmere-Insel. Dieser Zeitunterschied in den glazialisostatischen Anpassungen läßt eine erhebliche Schwankung in der Reaktionszeit des Gletschers und/oder glazialklimatischen Systemen in diesem Gebiet vermuten. In diesem ganzen Gebiet ging die äußerste Eisgrenze etwa 40-60 km über die heitigen Eisgrenzen hinaus. Das maximale Auftauchen an diesen Eisgrenzen ist durch Küstenlinien markiert, die in ein volles glaziales Eismeer hineingebaut sind und welche von 124 m über dem Meeresspiegel in der Bucht von Clements Markham bis zu 150 m über dem Meeresspiegel in Hall Land reichen. Das zeigt, daß ein vergleichbares Auftauchen (120-150 m) in anderen Gebieten nicht unbedingt den Rückzug der ganzen Eiskappen erfordert, auch wenn dies allgemein in der Fachliteratur angenommen wurde.

INTRODUCTION

The amount of postglacial emergence is commonly thought to reflect the magnitude of a former ice load and regional isobases drawn on postglacial shorelines are used to infer the pattern of the ice cover (*cf.* ANDREWS, 1968, 1970). In Arctic Canada, BLAKE (1970) reported a ridge of greatest Holocene emergence running from Bathurst Island to Eureka Sound. From this he concluded that an 'Innuitian Ice Sheet' inundated the eastern Queen Elizabeth Islands during the last glaciation when it presumably coalesced with the Greenland Ice Sheet in Nares Strait and the Laurentide Ice Sheet in Lancaster Sound (Fig. 1). WALCOTT (1970) also contoured a ridge of maximum emergence extending from near Bathurst Island, across Ellesmere Island, to northwest Greenland which he named the 'Innuitian Uplift'.

ENGLAND (1976a, 1982) on the other hand, interpreted this emergence data in a different manner. He suggested that the isobases in the eastern Queen Elizabeth Islands had a gradient and orientation that reflected the ultimate dominance by the Greenland Ice Sheet (Fig. 2a). He also argued that since the lithosphere is rigid, an ice load will depress the land beyond its margin (BROTCHIE and SILVESTER, 1969; WALCOTT, 1970), therefore, Greenland and Ellesmere Island ice did not have to coalesce to produce this emergence pattern. Using a geophysical model (BROTCHIE and SILVESTER, 1969), ENGLAND (1974) reproduced the observed postglacial isobases by assumming a retreat of *ca.* 100 km by the Greenland Ice Sheet and *ca.* 60 km by the Ellesmere Island ice following the last glaciation. However, this geophysical model has limitations because it assumes that complete isostatic equilibrium has been attained and it does not include restrained rebound before deglaciation.

Conversely, WEIDICK (1976) took a similar data base along Nares Strait and contoured it to indicate maximum emergence extending from Hall Land to Ellesmere Island via the central part of the strait (Fig. 2b). In both cases (ENGLAND, 1976a; WEIDICK, 1976) the isobases increase in value southward from the Lincoln Sea, toward northern Ellesmere Island and northwest Greenland (Fig. 1). Moreover, both sets of isobases extend smoothly from northernmost Greenland to Ellesmere Island where they trend obliquely across the northern coast towards the west. The overall difference between the two reconstructions is due to the sparsity of control points, for example ENGLAND (1976a) had only two sites on the entire north coast of Ellesmere Island. Because of this shortage of data PATERSON (1977) noted that different authors could provide different interpretations and he also questioned whether isostatic equilibrium was attained by each successive glaciation.

In order to determine the extent and timing of different glaciations, primary geological evidence must be given precedence over postglacial emergence (BOULTON, 1979). In turn, emergence data will be understood best in the context of the documented ice retreat responsible for it. Because of this, the study of postglacial emergence along northern Nares Strait has been accompanied by studies on the extent of the last and earlier glaciations on northeast Ellesmere Island (ENGLAND, 1976b, 1978; ENGLAND and BRADLEY, 1978; ENGLAND *et al.*, 1978, 1981). More recently, ENGLAND (1983) documented the former existence of a "full glacial sea" that occupied an ice-free corridor between northeast Ellesmere

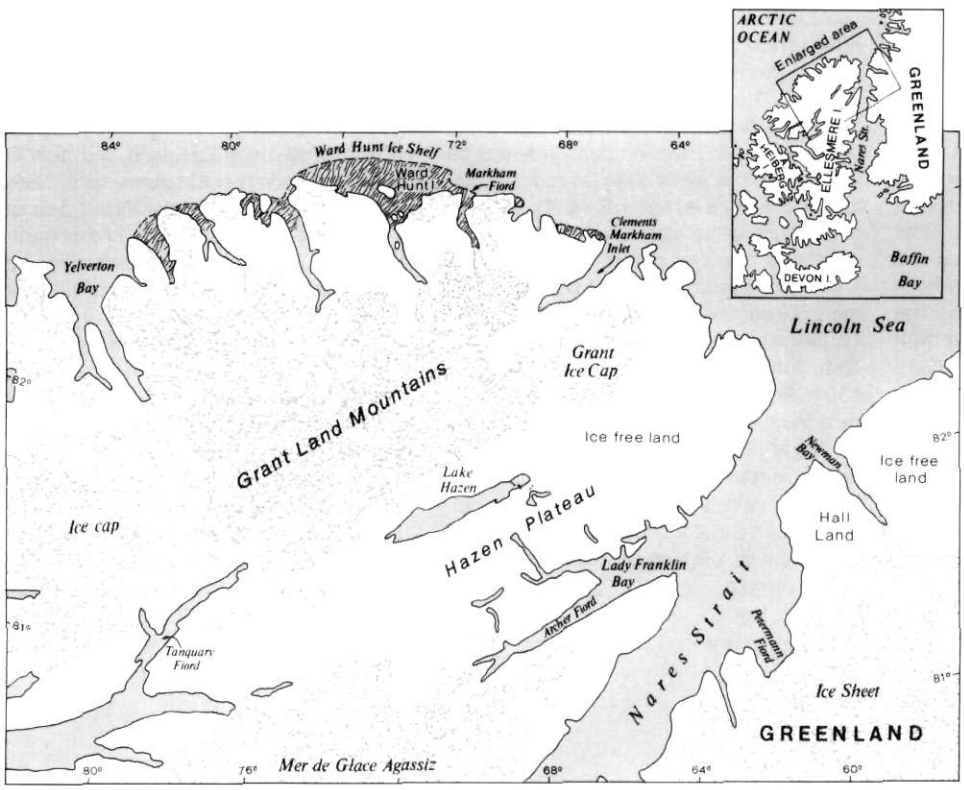

FIGURE 1. Principal place names and distribution of present ice (shaded) on northern Ellesmere Island and northwest Greenland. Field area is shown on the inset. (Figure courtesy of the *Canadian Journal of Earth Sciences*.)

Toponymie et répartition des glaciers (en gris) du nord de l'île d'Ellesmere et du nord-ouest du Groenland. (L'autorisation de reproduire cette figure a été accordée par le Journal canadien des sciences de la Terre.)

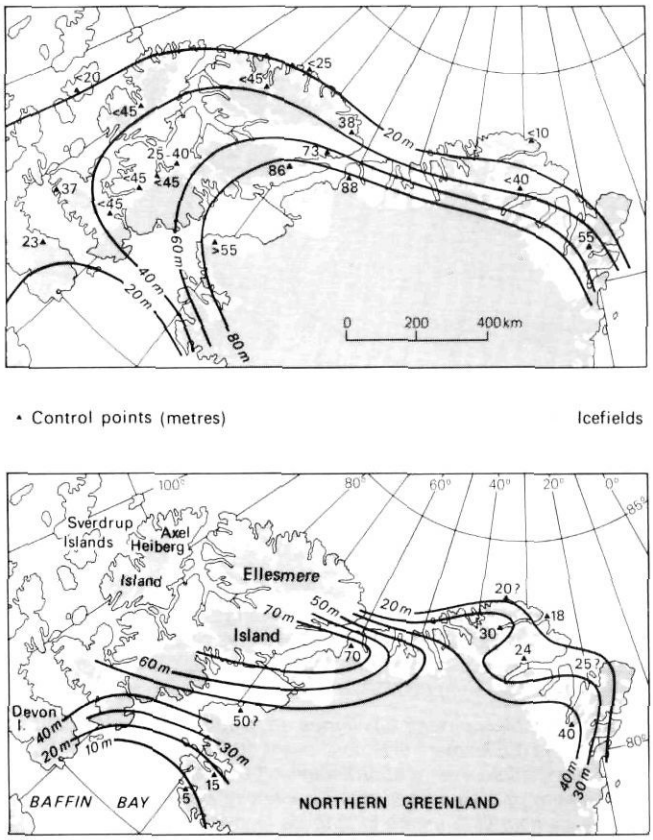

FIGURE 2. a) Regional isobases over Queen Elizabeth Islands and northern Greenland for 6000 BP (ENGLAND, 1976a; eustatic correction + 6 m). b) Regional isobases for the same area based on minimum values for 6000 BP (WEIDICK, 1976).

a) Isobases régionales de l'archipel de la Reine-Elizabeth et du nord du Groenland à 6000 BP (ENGLAND, 1976a; correction eustatique + 6 m). b) Isobases régionales du même secteur selon les valeurs minimales établies pour 6000 BP (WEIDICK, 1976).

Island and Greenland during the last glaciation. The limit of this full glacial sea trims weathered till and higher shorelines deposited during older glaciations and therefore it provides a direct measure of the glacioisostatic unloading of this area. The limit of this full glacial sea rises toward northwest Greenland as the earlier reconstructions of the isobases suggest (ENGLAND, 1976a; 1982).

This paper combines recent fieldwork on Hall Land, northwest Greenland (ENGLAND, 1985), and in Clements Markham Inlet, northern Ellesmere Island (BEDNARSKI, 1984, 1986). This work adds considerably to our previous understanding of the last ice limit in this region and approximately 150 ^{14}C dates are now available on raised marine shorelines both on the proximal and distal sides of these former ice margins. All of these Holocene dates are presented in Tables published previously by ENGLAND (1983; 78 dates) from northeast Ellesmere Island; ENGLAND (1985; 27 dates) from Hall Land; and BEDNARSKI (1984, 1986, 45 dates) from Clements Markham Inlet. The expanded data base from Clements Markham Inlet and Hall Land (> 70 new ^{14}C dates) warrants the modification of the previously proposed isobases. In his earlier work, ENGLAND (1976a, 1982, 1983) stressed the proximity of northeast Ellesmere Island to the Greenland Ice Sheet which controlled its history of glacioisostatic loading and unloading. The advantage of our recent fieldwork from Hall Land is that it provides data along the very margin of the dominant Greenland ice load where the earlier Ellesmere Island model can be tested. On the other hand, the advantage of our recent fieldwork in Clements Markham Inlet is that it provides information from an area *beyond* the glacioisostatic influence of the Greenland ice load, assuming that its peripheral depression is < 200 km (WALCOTT, 1970).

NEW DATA

On Hall Land, northwest Greenland, the last ice limit is marked by prominent moraines in Newman Bay and Petermann Fiord (Fig. 1) that extend 40-60 km beyond the present ice margins. Distal to these moraines, *in situ* shells related to the marine limit range from 8200 to > 33,000 BP and record the presence of a stable full glacial sea now uplifted to 150 m asl (ENGLAND, 1985). This limit of the full glacial sea descends to 116 m asl on the adjacent coast of northeast Ellesmere Island (Fig. 1; ENGLAND, 1983). Initial emergence in Hall Land coincides with the initial retreat of the Newman Bay glacier at 7965 ± 115 BP (S-2301) and with the initial retreat of the Petermann Glacier at 8280 ± 90 BP (S-2313; ENGLAND, 1985). Initial emergence on the adjacent coast of Ellesmere Island also occurs *ca.* 8000-8200 BP, confirming the glacioisostatic control of the Greenland Ice Sheet on both sides of northern Nares Strait. In this area emergence proceeded slowly between *ca.* 8000 BP and 6200 BP after which emergence and glacial unloading were rapid (ENGLAND, 1983).

During the last glaciation in Clements Markham Inlet, northern Ellesmere Island (Fig. 1), outlet glaciers from the Grant Land Mountains advanced approximately 40 km beyond their present ice margins in the main valleys. During this time only the head of the inlet was inundated by the main trunk glacier, while smaller glaciers, along the sides of the inlet, calved into a full glacial sea (BEDNARSKI, 1984, 1986). Radiocarbon ages on marine shells indicate that the last ice limit was reached by at least 9800 BP. The full glacial sea reached a maximum of 124 m asl at this ice limit and descended to 92 m asl at the mouth of the inlet, 50 km to the northeast. Slow retreat occurred from at least 10,000 to 8000 BP which coincides with a gradual drop in relative sea level. After 8000 BP the head of the inlet became ice-free within 400 years, at most, which coincides with rapid postglacial emergence.

Figures 3, 4, and 5 present the isobases for 10,000, 8000 and 6000 BP, respectively. Data points which define the isobases are shown on the maps and their corresponding site numbers and sources are also listed in Table I. The isobases drawn on shorelines dated 6000 BP (Fig. 5) are similar to those drawn by ENGLAND (1976a, 1982), however, the earlier isobases (8000 and 10,000 BP) require modification. Many of the control points for the new isobases are derived from emergence curves and equidistant diagrams and these are considered to have an accuracy of ± 5 m (Table I). However,

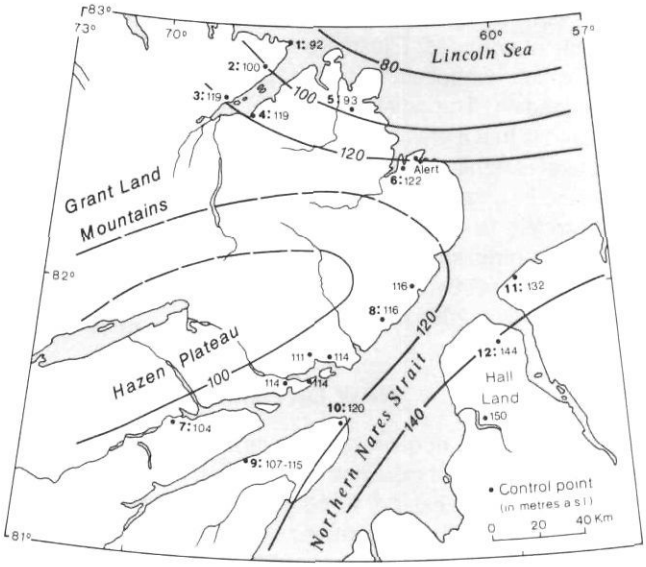

FIGURE 3. Isobases drawn on 10,000 BP shorelines on northern Ellesmere Island and northwest Greenland. Site numbers (bold) and related elevations in meters (see Table I). These record the relative magnitude of the last ice load, *i.e.* the limit of the full glacial sea. Dashed lines of cell are provisional. Elevations without site numbers along the north shore of Lady Franklin Bay show additional locations where the limit of the full glacial sea was surveyed at 111-116 m asl.

Isobases établies à partir des lignes de rivage de 10 000 BP dans le nord de l'île d'Ellesmere et le nord-ouest du Groenland. Les numéros des sites sont en gras et les altitudes relatives, en mètres (tabl. I). Ces altitudes donnent l'importance relative des dernières masses glaciaires, c.-à-d. les limites d'englaciation de la mer. Les lignes tiretées du compartiment sont provisoires. Les altitudes (sans numéro de site) le long de la rive nord de la baie de Lady-Franklin identifient d'autres endroits où les limites de 111-116 m anm d'englaciation de la mer ont été enregistrées.

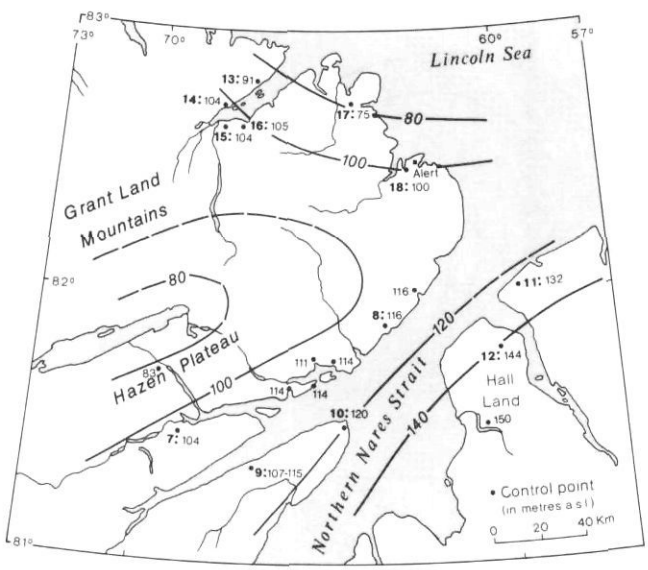

FIGURE 4. Isobases drawn on 8000 BP shorelines on northern Ellesmere Island and northwest Greenland. Note that slow initial emergence has occurred on northermost Ellesmere Island, bordering the Lincoln Sea, while the marine limit was maintained along northern Nares Strait (since 10,000 BP).

Isobases établies à partir des lignes de rivage de 8000 BP dans le nord de l'île d'Ellesmere et le nord-ouest du Groenland. À noter que l'émersion initiale s'est d'abord manifestée à l'extrême nord de l'île d'Ellesmere, qui entoure la mer de Lincoln, pendant que la limite marine demeurait la même le long de la partie nord du détroit de Nares (depuis 10 000 BP).

the surveyed limit of the full glacial sea (10,000 BP) is considered to have an accuracy of ± 2 m and it ranges from 92 to 150 m asl across this area. We emphasize that the equidistant diagrams in Clements Markham Inlet is constructed by dated control points and partial emergence curves throughout the Inlet and therefore provides reliable data (BEDNARSKI, 1986).

The shoreline displacements in Clements Markham Inlet define an isobase pattern approximately orthogonal to the inlet (BEDNARSKI, 1984, 1986). This indicates that the previously published isobases should be corrected so that they swing farther north where they cross Robeson Channel from Greenland (compare Figs. 2a and 5). Furthermore, shorelines for a given age within the Inlet are higher than previously indicated, consequently the revised isobases must also be displaced northwards towards the Lincoln Sea (Fig. 1). The revised isobase maps (Figs. 3, 4, and 5) indicate that the recession of the ice caps in the Grant Land Mountains had a more significant effect in deflecting the isobases from northwest Greenland than was previously envisaged. In fact, a separate centre of uplift within the Grant Land Mountains is recognized. This centre, in turn, must produce a cell of lower emergence over the Hazen Plateau, between the higher values caused by the Grant Land Mountain and Greenland

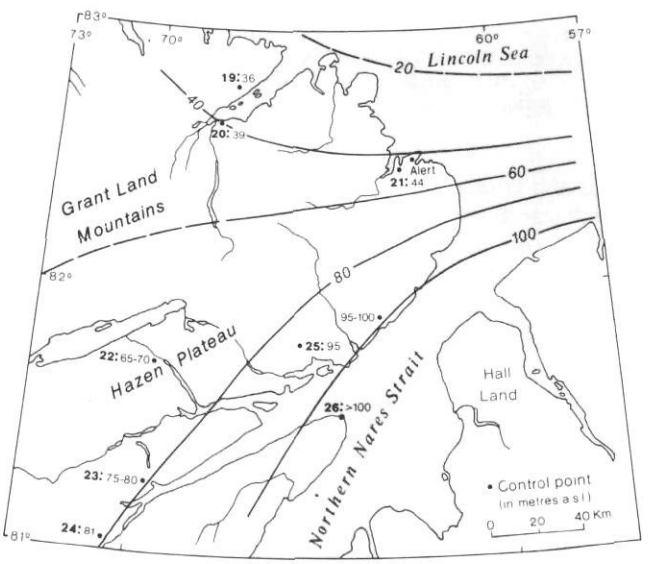

FIGURE 5. Isobases drawn on 6000 BP shorelines on northern Ellesmere Island and northwest Greenland. Note that most of the emergence along northern Nares Strait occurs since 6000 BP and this dominates the pattern.

Isobases établies à partir des lignes de rivage de 6000 BP dans le nord de l'île d'Ellesmere et le nord-ouest du Groenland. À noter que la plus grande partie de l'émersion le long de la partie nord du détroit de Nares se produit depuis 6000 BP et que cette caractéristique domine le modèle.

TABLE I
Control points for isobases

Site No.	Location	Est. elev. (m asl)	Age (BP)	Source
1	Outer Clements Markham Inlet	92	10,000	equidistant diagram; Bednarski, this issue
2	Central Clements Markham Inlet	100	10,000	equidistant diagram; Bednarski, this issue
3	Inner Clements Markham Inlet	119	10,000	emergence curve; Bednarski, this issue
4	*Inner Clements Markham Inlet*	*119*	*10,000*	*emergence curve; Bednarski, this issue*
5	Inland of James Ross Bay	93	10,000	emergence curve; England 1983
6	Alert	122	10,000	emergence curve; England 1983
7	Ida Bay	104*	10,000 & 8000	emergence curve; England 1983
8	Beaufort Lakes	116	10,000 & 8000	emergence curve; England 1983
9	Packdog Creek	107-115	10,000 & 8000	emergence curve; England 1983
10	Cape Baird	120	10,000 & 8000	emergence curve; England 1983
11	N.W. Nyboe Land	132	10,000 & 8000	marine limit; see England 1985
12	W. Newman Bay	144	10,000 & 8000	marine limit; see England 1985
13	Central Clements Markham Inlet	91	8000	equidistant diagram; Bednarski, this issue
14	*Inner Clements Markham Inlet*	*104*	*8000*	*emergence curve, Bednarski, this issue*
15	Inner Clements Markham Inlet	104	8000	emergence curve; Bednarski, this issue
16	Inner Clements Markham Inlet	105	8000	emergence curve; Bednarski, this issue
17	Inland of James Ross Bay	75	8000	emergence curve; England 1983
18	Alert	100	8000	emergence curve; England 1983
19	Central Clements Markham Inlet	36	6000	equidistant diagram; Bednarski, this issue
20	Inner Clements Markham Inlet	39	6000	equidistant diagram; Bednarski, this issue
21	Alert	44	6000	emergence curve; England 1983
22	Chandler Fiord	65-70	6000	emergence curve; England 1983
23	Simmonds Bay, Archer Fiord	75-80	6000	emergence curve; England 1983
24	Ella Bay, Archer Fiord	81	6000	emergence curve; England 1983
25	Muskox Bay	95	6000	emergence curve; England 1983
26	Cape Baird	>100	6000	emergence curve; England 1983

* Sites 7 through 12 have the same elevations at 10,000 and 8000 BP because relative sea level remained stable at the limit of the full glacial sea (cf. England 1983, 1985).

ice loads (Fig. 3). The configuration of the cell cannot be determined accurately because of the lack of control points. However, this cell of lower emergence must have diminished between 10,000 and 8000 BP because emergence during this interval occurred slowly in the Grant Land Mountains while sea level remained stationary along northern Nares Strait (Figs. 3 and 4). After 8000 BP, rapid retreat of glaciers along northernmost Ellesmere Island caused accelerated emergence there which, in turn, led to the disappearance of the cell by 6000 BP (Fig. 5).

The above reconstruction is governed by the different history of glacial unloading, hence emergence, that occurred between northernmost and northeast Ellesmere Island (ENGLAND, 1983). On northeast Ellesmere Island, ENGLAND (1983) describes a full glacial sea maintained from at least 11,000 to 8000 BP. The full glacial sea predates any glacial unloading by at least 1000-3000 years. This stable period (11,000 to 8000 BP) was followed by an interval of slow initial emergence (0.7 m 100 yr^{-1}) from 8000 to 6200 BP, and a subsequent interval of 'normal', rapid emergence that extends to the present. ENGLAND (1985) showed that initial unloading also occurred on northwest Greenland between 8000 and 8200 BP when local ice retreat allowed the initial transgression of the sea inside the last ice limit. As can be seen, a difference of *ca.* 2000 years occurs between the onset of slow emergence along northern Nares Strait (*ca.* 8000 BP) and its onset in Clements Markham Inlet where it began by at least *ca.* 10,000 BP (BEDNARSKI, 1984, 1986). This earlier unloading of northenmost Ellesmere Island extended eastward at least as far as Alert, where ENGLAND's (1983, Fig. 7) revised emergence curve is similar to that from Clements Markham Inlet. Despite the different unloading histories between northernmost Ellesmere Island on the one hand, and northeast Ellesmere Island and northwest Greenland on the other, the isobases shown for 10,000 BP (Fig. 3) closely reflect the *maximum* depression, and hence, the total crustal loading caused by the last glaciation. This is due to the fact that the 10,000 BP isobases are based on the profile of the marine limit in the full glacial sea. Consequently, the low cell in the isobases over the Hazen Plateau (Figs. 3 and 4) is not simply an artifact of different glacioclimatic responses between the above areas, but rather it reflects the relative distribution of the last ice load.

The nonsynchronous nature of regional emergence is emphasized in Figures 6 and 7. These figures are derived from the isobase maps (Figs. 3, 4 and 5) whereby the 8000 BP isobases are subtracted from the 10,000 BP isobases (for Fig. 6) and the 6000 BP isobases are subtracted from the 8000 BP isobases (for Fig. 7). These results record the different amounts of emergence that occurred accross the area during these two intervals. For example, during the interval 10,000-8000 BP slow, uniform emergence (20 m) occurred over the northern Grant Land Mountains, while the area of northern Nares Strait remained stable (Fig. 6). After 8000 BP rapid emergence occurred in the northern Grant Land Mountains (Fig. 7), while the formerly stable area of northern Nares Strait began to emerge slowly. After 6000 BP emergence along northern Nares Strait attained a rate of *ca.* 3.5 m 100 yr^{-1} which was similar to the rapid rate attained in the northern Grant Land Mountains after 8000 BP.

The three sets of isobases we have presented describe a general progression of postglacial unloading which began 2000 years earlier along the north coast of Ellesmere Island than it did along northern Nares Strait. Consequently, this caused a fundamental change in the gradients of the isobases during the early Holocene (Figs. 3 and 4 *vs.* 5). Emergence along the Ellesmere Island side of Nares Strait is considered to be primarily governed by reduction in the northwest Greenland ice load (ENGLAND, 1976a, 1976b, 1982, 1983). This may explain the lag in initial emergence in this area compared to the earlier and largely independent emergence further to

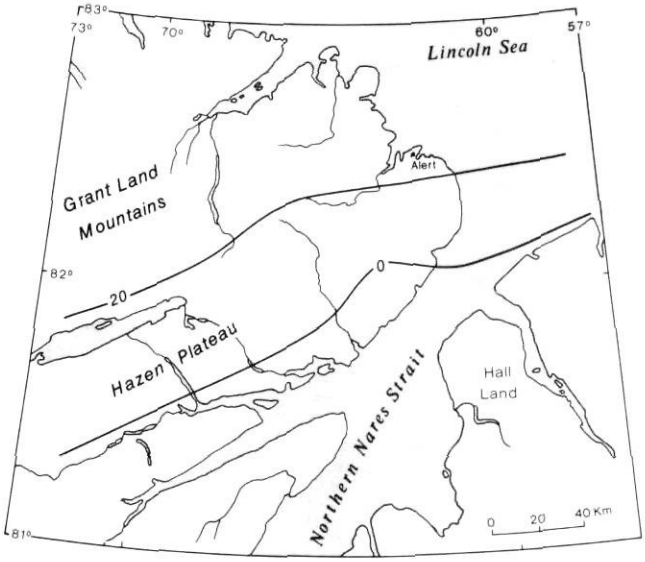

FIGURE 6. Emergence (meters) that occurred on northern Ellesmere Island and northwest Greenland between 10,000 and 8000 BP (derived from difference between Figs. 3 and 4).

Amplitude de l'émersion (en mètres) dans le nord de l'île d'Ellesmere et le nord-ouest du Groenland entre 10 000 et 8000 BP (résultant de la différence entre les fig. 3 et 4).

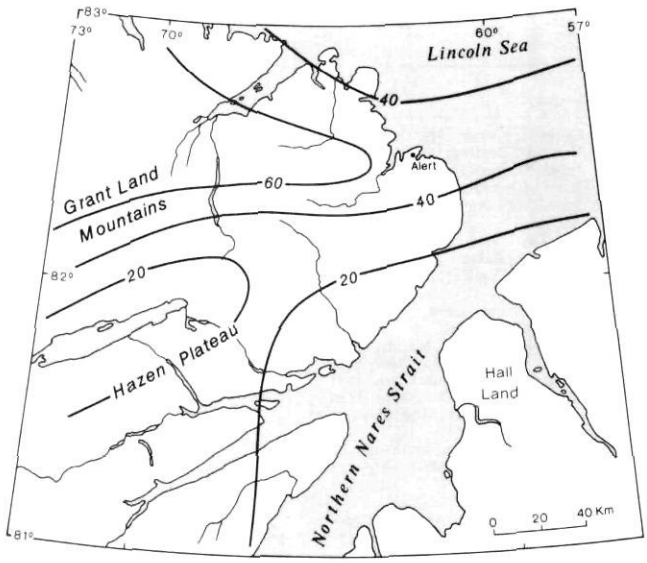

FIGURE 7. Emergence (meters) that occurred on northern Ellesmere Island and northwest Greenland between 8000 and 6000 BP (derived from difference between Figs. 4 and 5).

Amplitude de l'émersion (en mètres) dans le nord de l'île d'Ellesmere et le nord-ouest du Groenland entre 8000 et 6000 BP (résultant de la différence entre les fig. 4 et 5).

the northwest in the Grant Land Mountains. Consequently, earlier retreat of the Ellesmere Island ice may explain this 2000 year lag (ENGLAND, 1983, p. 911).

It has been suggested that the large isotopic shift at *ca.* 10,500 BP in the Greenland and Devon Island ice cores indicates an abrupt climatic amelioration (DANSGAARD *et al.*, 1973; KOERNER and FISHER, 1981). If this or a related glacioclimatic interpretation is correct, the question that follows is what response time would be required to initiate rapid retreat of these ice sheets following such an amelioration? If the approximate response times for the Ellesmere Island ice caps and the Greenland Ice Sheet are *ca.* 2500 and 4000 years, respectively (due to their difference in size, D. Fisher, pers. comm., 1983), it is possible that the Ellesmere Island ice began to retreat at 8000 BP, followed by the larger Greenland Ice Sheet at 6500 BP. Because it is likely that some reduction in glacier mass would occur after the onset of the proposed warming or circulation change at 10,500 BP, and before rapid retreat (ca. 8000-6000 BP), it is noteworthy that slow glacial retreat was already underway in Clements Markham Inlet by *ca.* 9800 BP. On the other hand, ENGLAND (1982, 1983, 1985) found that glaciers on northeast Ellesmere Island and northwest Greenland began to retreat slowly *ca.* 8000 BP, when deglaciation in Clements Markham Inlet was well underway. Furthermore, most glaciers on the Hazen Plateau, northeast Ellesmere Island, remained within a few kilometres of the last ice limit until *ca.* 6200 BP (ENGLAND, 1983). To reconcile earlier unloading in the north, ENGLAND (1983) suggested that a significant difference in glacioclimatic regimes may have occurred between the north and south sides of the Grand Land Mountains. It appears that the dated ice margins bear this out. Furthermore, these different glacioclimatic regimes may be related to the influence of the Arctic Ocean on the glaciers along the northernmost coast of Ellesmere Island (*cf.* HERMAN and HOPKINS, 1980). The present influence of the Arctic Ocean on the glaciers of northernmost Ellesmere Island is indicated by the equilibrium line altitude and the glaciation level which descend below 300 m asl compared to elevations of 1100 m asl farther south on the Hazen Plateau (MILLER *et al.*, 1975).

SUMMARY

Recent work on shoreline displacements along the northern coast of Ellesmere Island (BEDNARSKI, 1984, 1986) indicate that this region is beyond the isostatic influence of the northwest Greenland Ice Sheet. The new isobases define a centre of uplift in the northern Grant Land Mountains which in turn leads to a low cell in the Lake Hazen area to the south. Southeast from this cell, across northeast Ellesmere Island, shorelines rise toward the northwest Greenland Ice Sheet (ENGLAND, 1976a, 1983). Recent fieldwork in Hall Land, northwest Greenland, confirms that the shorelines continue to rise across northern Nares Strait (ENGLAND, 1985). The former glacial loading in the northern Grant Land Mountains diminished rapidly after 8000 BP while the loading over Lake Hazen was maintained until 6200 BP (ENGLAND, 1983). The 2000 year lag in emergence between the north and southeast sides of the Grant Land Mountains is probably due to the dissimilar glacioclimatic regimes between the two areas, as well as to the different response times affecting the Greenland and Ellesmere Island ice masses (ENGLAND, 1983, 1985; BEDNARSKI, 1984).

Much of the postglacial emergence we report from northern Ellesmere Island and northwest Greenland is marked by the

limit of a former full glacial sea which bordered the last ice limit (ENGLAND, 1983, 1985; BEDNARSKI, 1984, 1986). Consequently, in these areas we report the total postglacial emergence unaffected by restrained rebound (*cf.* ANDREWS, 1970). Emergence from the full glacial sea reaches 150 m along the last ice limit on Hall Land and 124 m in Clements Markham Inlet. Hence, although this amount of postglacial emergence (124-150 m) is commonly cited as evidence for a former ice sheet over the Queen Elizabeth Islands (BLAKE, 1970, 1975), we show that this could be caused by the retreat of outlet glaciers by *ca.* 40-100 km (beyond their present limits). As a result, it is incorrect to assume that this amount of emergence marks the centre of a former ice sheet. The geophysical implications of this deserve further attention.

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