dered by the conflicting nature of the ongoing dialogue on such subjects. This Administration, for example, has recently proposed a general income tax reduction which by its nature can only buy time. By giving us a little more take-home pay, it can relieve the pressures for wage and price increases, but only if all of the parts fall into place and all of the parties of interest behave accordingly. Yet economists, who often offer such temporary and shakey solutions, are among the President's most favored and visible advisers while scientists, who are specially qualified to develop adequate knowledge and understanding of the issues themselves, struggle to be heard and have little public exposure. Like economics or law, science is a way of looking at things, of studying and handling them. Despite that, and although we have long since identified law and economic theory as of sufficient importance to require the establishment of national priorities concerning them, we continue with regard to science to subgrade its policy structure and thus diminish its utilization as an equally important social tool.

Since the Legislative Branch has given impetus to such an effort, it would seem worthwhile for the Executive Branch to take up the challenge in full. The costs of doing so are relatively small, the risks are few, and the payoffs could be great.

As I see it, one important aspect of the AAAS responsibility is the assessment of the role of government in influencing the course and the conditions of science in our society. Another, perhaps equally important aspect is the role of science and technology in contributing to the goals and purposes of our national government. The present and prospective condition of American society makes both of these responsibilities perhaps more important and compelling of official recognition than in the past.

I am not speaking of the limited or parochial interests of the membership of the Association. True, we have a traditional concern for the health and stability of the scientific enterprise in the United States, and the condition of science remains of fundamental interest. I do suggest, however, that we must also have a larger mission today than the preservation and support of the scientific establishment in the United States. When President Carter came to the White House, he brought with him a list of declarations, promises, and policy positions. I do not think he should be faulted for this—and too often he has been. As the poet says, "Man's reach ever should exceed his grasp, or what's a Heaven for?"

Our aspirations ought to run ahead of our daily achievement, or life loses its joys, its excitements, its very meaning. When the President calls for a heightened efficiency of the Executive Branch of government, we certainly share his aspiration. When the President declares the intention of striving for a balanced budget by 1981—he should not be faulted for a hope that most of us share. We also share his recognition that a sound fiscal policy is essential to the control of inflation, the preservation of the value of the dollar, and the incentive for investment in America's future. What I suggest, before this forum of America's scientists and technologists, is that we not only share the aspirations for a better America, we also share the means for achieving progress toward them.

Past Glacial Activity in the Canadian High Arctic

For at least 30,000 years ice-free areas have existed between Greenland and Ellesmere Island ice sheets.

J. England and R. S. Bradley

Northeast Ellesmere Island and northwest Greenland are separated by only 20 to 40 kilometers along the lengths of Kennedy and Robeson channels (Fig. 1). In this area the present-day United States Range and Agassiz ice caps on Ellesmere Island are but 150 km from the margin of the Greenland Ice Sheet. The intervening landscape along both coastlines is characterized by dissected plateaus and mountains of low to moderate elevation (300 to 1200 meters above sea level). The topography of Ellesmere Island and its proximity to Greenland make it an ideal location for investigating the past interactions of their respective ice sheets. Recent fieldwork on the coastal areas between these ice sheets has provided new information on past glacial activity in the region that is directly relevant to both paleoclimatic and chronological interpretations of high-latitude ice cores (*1*).

In recent literature it has been generally assumed that the Greenland Ice Sheet was contiguous with an ice sheet over the Canadian Arctic islands during the last glaciation (*2*). More specifically, it has been proposed that from at least 59,000 to approximately 13,000 years before present (B.P.) there was a substantial ice ridge over Nares Strait (Fig. 1) built up to a width of about 700 to 800 km (*3*). The altitude of this ridge was estimated to be 2500 to 3000 m, and the ridge presumably joined the northwest Greenland Ice Sheet on Knud Rasmussen Land to the hypothesized Innuitian Ice Sheet over the Queen Elizabeth Islands. Evidence in support of such a major ice mass has been provided by the analysis of the total gas content from the Camp Century ice core, which suggests that the northwest Greenland Ice Sheet was about 1300 m thicker than today toward the end of the last glaciation (*4*).

By contrast, however, several authors have cited stratigraphic evidence for a restricted ice cover over northern and northwest Greenland during the late Quaternary (*5-7*). In general, the outermost glacial deposits in this region are considered to predate the last glaciation, on the basis of associated "old" radiometric dates, advanced rock weathering, and subdued moraine morphology (*8*).

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0036-8075/78/0421-0265$01.25/0

Summary. Field observations on northeast Ellesmere Island indicate that the maximum advance of the northwest Greenland Ice Sheet was about 100 kilometers beyond its present margin. This occurred before the outermost Ellesmere Island ice advance, which took place more than 30,000 years before present (B.P.). Recession from the Ellesmere Island ice margin began at least 28,000 to 30,000 and possibly more than 35,000 years B.P. During this sequence of glacial events, significant land areas remained free of ice. The late Wisconsin ice extent along both northeast Ellesmere Island and northwest Greenland was extremely limited, leaving an ice-free corridor along Kennedy and Robeson channels. Recession from these ice margins is indicated by initial postglacial emergence around 8100 to 8400 years B.P. The relatively minor extent of late Wisconsin ice in the High Arctic probably reflects a period of extreme aridity occasioned by the buildup of the Laurentide Ice Sheet to the south.

On the other hand, younger glacial deposits, believed to record the last major glaciation, occur closer to the present-day ice margins. Similar conclusions are considered applicable to northeast Ellesmere Island (*9*). The results presented here are directly related to this question of late Wisconsin ice extent in the region and suggest (i) a maximum northwest Greenland ice advance of great antiquity which extended onto northeast Ellesmere Island more than 80,000 years B.P.; (ii) a much reduced northwest Greenland Ice Sheet, and a maximum Ellsmere Island ice advance that reached Kennedy Channel more than 30,000 years B.P.; and (iii) limited late Wisconsin ice margins for both the northern Ellesmere Island and Greenland ice sheets, which began recession about 8100 to 8400 years B.P.

Maximum Extent of the Northwest Greenland Ice Sheet

During 1975 and 1976 we conducted fieldwork on Judge Daly Promontory, northeast Ellesmere Island (Fig. 1). The area investigated is 60 km west of the Petermann Glacier, which issues from the Greenland Ice Sheet. We planned to establish whether the Greenland Ice Sheet had advanced to Ellesmere Island and, if so, to map the profile of its uppermost erratics and date the oldest Ellesmere Island ice margin crosscutting it. Our observations were facilitated by the fact that the Ellesmere Island ice caps overlie, and hence transport, Phanerozoic sedimentary bedrock, whereas erratics from the Greenland Ice Sheet are derived, in part, from the crystalline basement of the interior Precambrian Shield.

Figure 2 shows the maximum profile of Greenland erratics observed on central Judge Daly Promontory (*10*). This uppermost zone of Greenland erratics is characterized by sparse granite, gneiss, and quartzite boulders resting on deeply weathered bedrock or embedded in its associated colluvium. The bedrock, predominantly Paleozoic sandstones, is extensively oxidized and frost-shattered to a depth of more than 1 m, and tors 1 to 3 m high are abundant. Thick sheets of soliflucting colluvium, comprised of comminuted and oxidized bedrock chips, have engulfed many of the erratic blocks. Much of this bedrock weathering is considered to have occurred after the deposition of the Greenland erratics, which also exhibit considerable frost shattering and granular disintegration. Such extensive weathering suggests that this former ice advance is of considerable antiquity. These conditions also parallel the advanced weathering noted on the outermost glacial deposits of Inglefield Land, northwestern Greenland, which were thought to correspond to the Greenland ice advance onto Ellesmere Island (*6*).

Along the central eastern coast of Judge Daly Promontory an ice-pushed moraine occurs immediately above Kennedy Channel at 200 m above sea level. This moraine is characterized by Greenland erratics, and it grades continuously into proglacial lacustrine sediments toward the interior of the promontory. Stratigraphically, the moraine represents the youngest glacial event within the zone of the Greenland erratics, and fragmented shells, presumably scoured out of Kennedy Channel, have been incorporated in it. A sample of these shells was ^{14}C dated at $14,360 \pm^{1120}_{1300}$ years B.P. (DIC-547; Fig. 2). However, this is probably a minimum date as only 5 grams were collected, no leaching was applied, and the porous nature of the shells made the removal of encrusted silica and calcite impossible (*11*). A second, larger sample was collected in 1976 and ^{14}C dated at 23,300 ± 310 years B.P. (S.I. 3298) after 20 percent of the surface material was removed with dilute HCl. We interpret these ^{14}C dates as minimum estimates; an estimate of the age of the first sample by amino acid analysis showed it to be older than shells incorporated in the outermost Ellesmere Island Moraines (see below), and a tentative age of >80,000 years has been suggested (*12*).

It is noteworthy that on Judge Daly Promontory, with 60 km of the present-day Petermann Glacier, the uppermost observable limit of the former Greenland Ice Sheet is only 600 m above sea level. Taking into account the elevation of the adjacent valley bottoms, these uppermost erratics suggest a maximum Greenland ice thickness of 350 to 600 m in the interior of the promontory. On the mountain summits above these erratics (Fig. 2, profile) the bedrock has been shattered by periglacial rock weathering to the extent that cryoturbation has formed well-developed frost hummocks. This degree of surface alteration represents a prolonged period of bedrock weathering, which is notably more advanced than that of the coarse felsenmeer which occurs among the uppermost zone of Greenland erratics. It is concluded that this upland area, above the limit of Greenland erratics, remained unglaciated, perhaps throughout the Quaternary (*13*).

Maximum Extent of Ellesmere Island Ice Sheet

Although the absolute age of the maximum Greenland Ice Sheet advance is unknown, a minimum estimate is provided by the age of the subsequent and outermost Ellesmere Island ice advance, which crosscuts the Greenland erratics at lower elevations (Fig. 2). This Ellesmere Island glaciation is characterized by moraines composed mainly of sedimentary lithologies whose gradients indicate thin, topographically controlled ice lobes extending across Judge Daly Promontory to Kennedy Channel. The termini of two ice lobes were investigated; the first originated from the interior of Judge Daly Promontory and flowed southward to Cape Defosse, and the second, 20 km to the northeast, was formed by southeastwardly flowing tributary ice from Lady Franklin Bay (Fig. 2). Both termini flowed into isostatically depressed embayments along western Kennedy Channel, where they were forced to float, forming ice shelves. Morphological evidence for ice shelves (*14*) is provided by steeply descending lateral moraines, which become abruptly horizontal for about 2 km in both valleys (*15*). The horizontal moraines and associated proglacial terraces are often fossiliferous down-valley from their apparent grounding lines. An outwash terrace formed in one of the valleys occupied by these ice shelves suggests a former relative sea level at 175 m. This is consistent with the water depths required to float the estimated thicknesses of both glaciers.

Fragmented shells from a proglacial terrace (~105 m above sea level) adjacent to the moraines at Cape Defosse were ^{14}C dated at 27,950 ± 5400 years B.P. (Fig. 2) (*8, 9*). Two amino acid age estimates for this sample (St 4325) and for a shell sample subsequently collected from the same terrace suggested that they were more than 35,000 years old (*12, 16*). Up-valley 3 km from the proglacial terrace, the Daly River (Fig. 2) has exposed a section of fossiliferous till overlying bedded sands. The till extends to an elevation of about 100 m above sea level, and it is considered to have been deposited in a marine environment since it occurs below both the local ice shelf moraine (~200 m above sea level) and the former relative sea level at 175 m. Fragmented shells from this till were dated at $28{,}610\ ^{+1710}_{-2180}$ years B.P. (DIC-550). The underlying bedded sands contain the locally extinct plant species *Dryas octopetala*, a sample of which was dated at more than 25,000 years B.P. (DIC-584). Adjacent to this section is a second, fossiliferous proglacial terrace about 105 m above sea level, estimated by amino acid analysis to date more than 35,000 years B.P.

The second ice shelf moraine occurs 20 km to the northeast in Beethoven Valley (Fig. 2) and immediately downslope is associated with a massive, proglacial marine terrace (175 m above sea level). Two samples of fragmented shells collected from these moraines and terraces were dated at $23{,}110\ ^{+660}_{-720}$ and $22{,}780\ ^{+810}_{-900}$ years B.P. (DIC-544 and DIC-546, respectively). Both ^{14}C dates are considered to be minimum estimates since the samples were encrusted with calcite (50 percent) and silica (50 percent), as determined by x-ray analysis. These contaminants could not be entirely removed and they may date, in part, from the recrystallization of the shells after their initial deposition. An amino acid age estimate for the older sample (DIC-544) was more than 35,000 years. Because of the controversial nature of these dates, the site of sample DIC-546 was revisited in 1976 and a larger, unencrusted shell sample was collected from the proglacial terrace. This 50-g sample (subjected to 25 percent leaching) was dated at $29{,}670\ ^{+830}_{-930}$ years B.P. (DIC-738), and this value takes precedence over the dates obtained earlier. An amino acid age estimate for DIC-738 again was more than 35,000 years (*12*). Finally, an age of 28,100 ± 380 years B.P. (GSC-1656) was previously determined (*17*) for organic debris collected from a marine limit delta along the southeastern edge of Hazen Plateau, 55 km northeast of these former ice shelves. The similarity of this date to those discussed above is apparent, and it may reflect a corresponding early recession of the Ellesmere Island Ice Sheet from southern Robeson Channel. However, this sample may have been contaminated by redeposited Tertiary material.

We conclude that these proglacial marine terraces, formed at least 28,000 to 30,000 years B.P., record initial deglaciation of the valleys occupied by the ice shelves (*18*). The establishment of the ice shelf moraines, however, may not be appreciably older (DIC-550). This general synchroneity in the Beethoven and Daly River valleys (Fig. 2) is logical, considering that the ice shelf moraines occur at similar elevations (~200 m above sea level) and represent similar ice thicknesses, which indicates that they were formed in the same (contemporaneous) sea level. Advanced surface weathering on these outermost moraines and terraces appears consistent with these early dates of deglaciation. These moraines, in turn, crosscut a much more severely weathered zone containing erratics previously deposited by the Greenland Ice Sheet (Fig. 2, profile).

Late Wisconsin Ice Extent: Northwest Greenland and Northeast Ellesmere Island

Opposite Judge Daly Promontory a former ice advance that extended out of Petermann Fiord (northwest Greenland) is marked by moraines that enter Hall Basin along the southwest margin of Polaris Promontory (*19*). Dated marine terraces related to this moraine system suggest that the ice advance is of Holocene age [<6100 years B.P.; sample W-816 (*20*)]. A minimum estimate of the extent of this ice margin would place the terminus of the Petermann Glacier in central Hall Basin, within 20 km of Judge Daly Promontory and the mouth of Lady Franklin Bay (Fig. 1). Evidence in support of this late Wisconsin advance is found on the Ellesmere Island side of Hall Basin, where differential postglacial emergence is strongly dominated by the

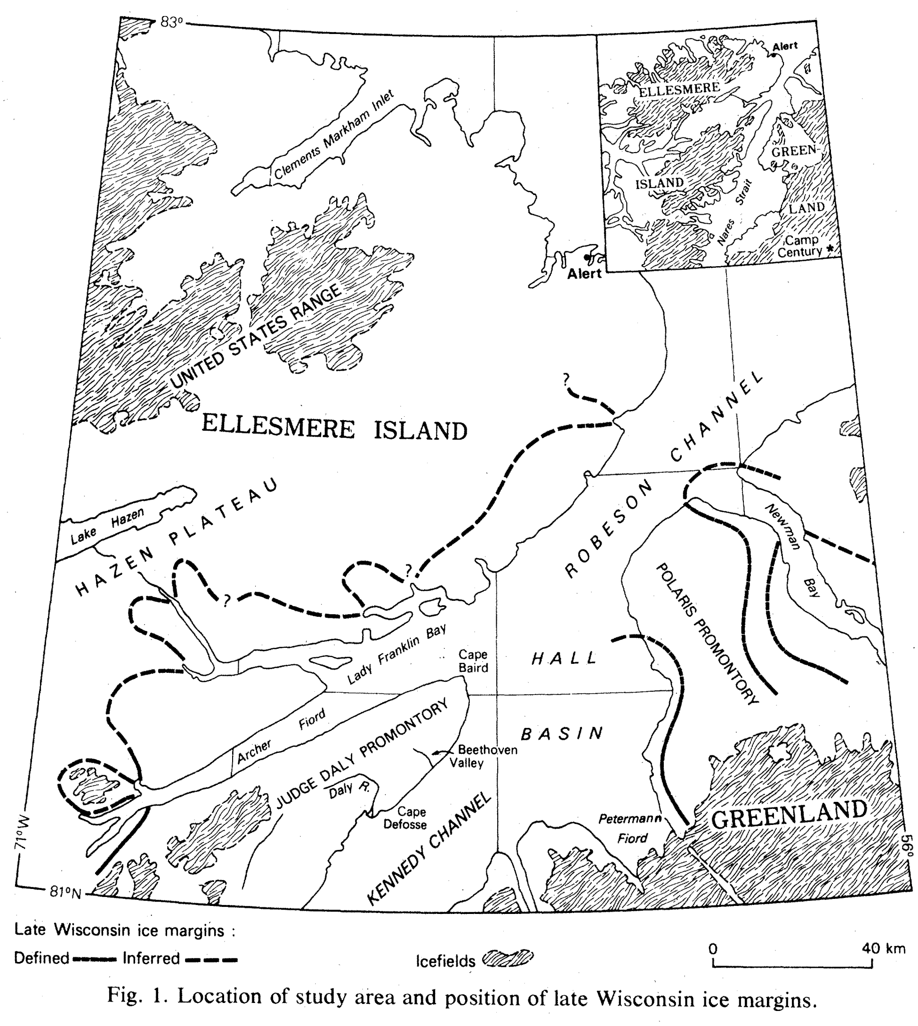

Fig. 1. Location of study area and position of late Wisconsin ice margins.

subsequent recession of the adjacent Greenland Ice Sheet (*21*).

Additional evidence that the northwest Greenland Ice Sheet occupied Hall Basin during the Holocene is provided by abundant, ice-rafted granite erratics deposited throughout Archer Fiord and Lady Franklin Bay on raised beaches up to the local marine limits. The frequency of these erratics suggests that Greenland ice was actively calving in Hall Basin and that Ellesmere Island glacier ice did not block the fiord. This is consistent with the restricted position of the late Wisconsin ice margin, delimited by the Hazen Moraines (*22*) (Fig. 2). Finally, a marine terrace at Cape Baird, at the northernmost tip of Judge Daly Promontory, is capped by granite erratics and its emergence of 110 m compares closely with the marine limit (107 to 110 m) on central Polaris Promontory (*23*). The similarity of these marine limit elevations probably reflects similar amounts of glacio-isostatic unloading and hence a comparable distance from the Greenland Ice Sheet margin controlling the depression. The initial emergence of the Cape Baird terrace is indicated by a sample of shells collected in situ and dated at 8380 ± 150 years B.P. (DIC-737); this probably reflects a synchronous recession of the bordering Greenland Ice Sheet.

It has been proposed that the northwest Greenland and northeast Ellesmere Island ice sheets did not merge during the late Wisconsin glaciation (*21*). This is indicated by the separation of their respective Holocene moraine systems and by the synchronous emergence in the intervening ice-free corridor, which suggests the decay of a marginal depression (*17, 24*). This synchronous emergence extends over a distance of 100 km and indicates initial glacio-isostatic unloading between the two ice margins 7500 to 8100 years B.P. (*25*). Additional evidence for synchronous emergence between the two ice margins is provided by raised marine deltas of Holocene age (see below) which occur on the distal sides of the ice shelf moraines and terraces dated at ≥28,000 to 30,000 years B.P. The latter valleys were clearly unoccupied by Holocene ice margins, and consequently their respective Holocene deltas are the product of fluvial sedimentation along an ice-free coastline depressed between the separated Greenland and Ellesmere Island ice margins. The Holocene marine limit on the distal side of the lower Daly River ice shelf was dated at 8200 ± 260 years B.P. (DIC-549), and a delta below the Beethoven Valley ice shelf was dated at 7910 ± 145 years B.P. (DIC-545) (*26*).

The date obtained for the lower Daly River Valley (8200 ± 260 B.P.) closely compares with the oldest date for initial emergence along the margin of the Hazen Moraines 70 km northwest (8130 ± 200 B.P., GSC-1775) and with the initial emergence of the Cape Baird terrace bordering the Greenland Ice Sheet margin in Hall Basin (8380 ± 105 B.P.). This projected synchronous emergence between the Ellesmere Island and northwest Greenland Ice Sheet margins is consistent with the glacio-isostatic dominance of the area by the Greenland Ice Sheet (*21*). Decay of the margin-

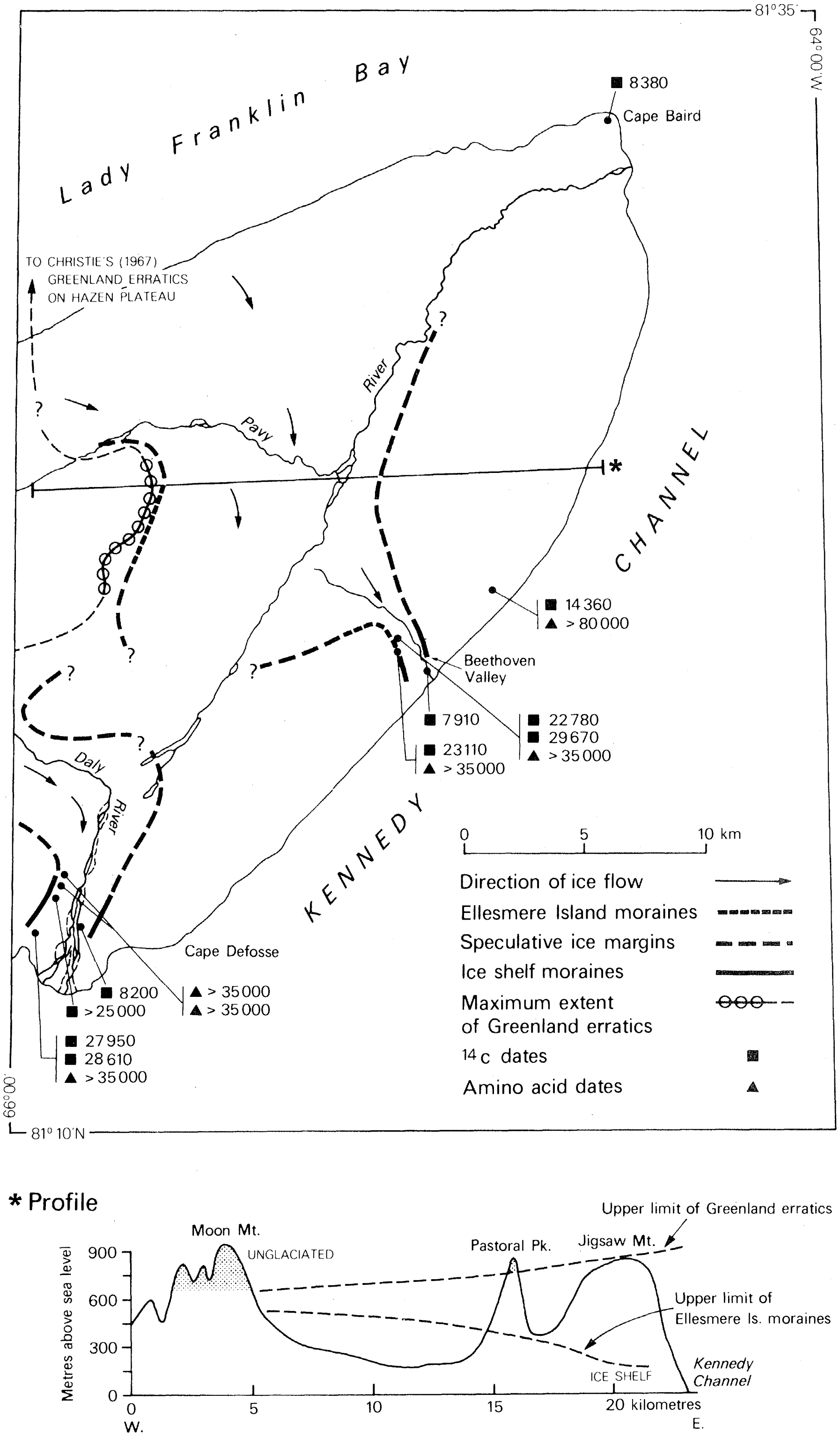

Fig. 2. Judge Daly Promontory, showing the maximum extent of Greenland erratics, the outermost Ellesmere Island moraines and ice shelves, and the sites of samples dated by the ^{14}C and amino acid methods. The profile of glacial deposits along the transect marked by an asterisk is shown at the bottom.

al depression over a distance of more than 100 km suggests early Holocene ice recession about 8100 to 8400 years B.P.; we find no glacio-isostatic evidence for a northwest Greenland ice advance less than 6100 years B.P. (*20*). Furthermore, that the Greenland Ice Sheet did not extend beyond Hall Basin during late Wisconsin time is demonstrated by the preservation of the ice shelf moraines along eastern Judge Daly Promontory and by the lack of ice-contact features on the adjacent coastline of Lady Franklin Bay. Independent estimates based on isotopic analyses of the Devon Island and Camp Century ice cores suggest that, during the late Wisconsin, the northwest Greenland Ice Sheet was only about 125 km beyond its present margin (*27, 28*).

Discussion

Multiple ice sheet margins predating the last glaciation, by both position and extent of rock weathering, have been reported along 3000 km of the eastern Laurentide ice margin, from Newfoundland and Labrador in the south to Baffin and Somerset islands in the north (*29–32*, respectively). Additional evidence of advanced weathering (on glacial deposits of presumably pre-late Wisconsin age) has been cited in the High Canadian and northwest Greenland Arctic (*6, 9, 19, 33*). Our results from northern Ellesmere Island reinforce these observations and suggest that there are at least four such weathering zones (Figs. 1 and 2) delimited, from oldest to youngest, by (i) unglaciated mountain summits, (ii) the maximum extent of Greenland erratics, (iii) the outermost Ellesmere Island Moraines, and (iv) the Hazen Moraines. The presence of these weathering zones supports earlier hypotheses favoring late Quaternary refugia over northeast Ellesmere Island (*34*).

It is apparent that the most recent advance of the Greenland Ice Sheet onto Judge Daly Promontory occurred more than 30,000 years B.P., whereas the uppermost till or tills within this zone may be much older. On the basis of the known distribution of erratics, the northwest Greenland Ice Sheet extended 20 to 70 km onto the adjacent Ellesmere coast—a distance of about 100 km beyond its present ice margin. It is also of interest that deglaciation from the outermost Ellesmere Island ice margin may have begun about 28,000 to 30,000 years B.P. This is particularly relevant to the hypothesis that astronomical variations exerted a strong control on glacial events in high latitudes (*35*). Recent calculations of circumpolar received solar radiation indicate a major trough about 33,000 to 25,000 years B.P., which would have resulted in extreme cold at high latitudes (*36*). In fact, this is indicated by the oxygen isotopic record from the Camp Century ice core (~78°N), which shows the onset of extreme cold about 31,000 years B.P. (*37*). Although it is likely that these conditions would favor the expansion of the southern Laurentide Ice Sheet, in higher latitudes it is much more likely that lower temperatures would lead to greater aridity and hence glacial recession. Indeed, paleoclimatic models support the concept of lower precipitation in high latitudes during the maximum extent of the late Wisconsin Laurentide Ice Sheet (*38*), as such a topographic barrier would effectively restrict advection of moisture from the south into the arctic archipelago and result in "starvation" of ice bodies to the north. Similarly, a better correspondence between the Camp Century ice core chronology and other independent chronologies was found when net accumulation rates were assumed to be less than present-day values (*39*). Our evidence indicates that periods of extreme cold lead to diminishing ice extent at high latitudes as a result of lower precipitation. We therefore do not support the idea that there were extensive late Wisconsin ice sheets over the Arctic Ocean (*40*) and adjacent lands of North America and Greenland (*2, 3*).

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41. Research supported by the Climate Dynamics Program, Climate Dynamics Research Section, Division of Atmospheric Sciences, National Science Foundation. Additional logistical support was provided by the Polar Continental Shelf Project, Department of Energy, Mines and Resources, Ottawa. We are grateful to Drs. R. Stuckenrath and G. H. Miller, respectively, for performing carbon-14 and amino acid analyses.

Improving Cognitive Ability in Chronically Deprived Children

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Summary. Beginning at different ages in their preschool years, groups of chronically undernourished children from Colombian families of low socioeconomic status participated in a program of treatment combining nutritional, health care, and educational features. By school age the gap in cognitive ability between the treated children and a group of privileged children in the same city had narrowed, the effect being greater the younger the children were when they entered the treatment program. The gains were still evident at the end of the first grade in primary school, a year after the experiment had ended.

In recent years, social and economic planning in developing countries has included closer attention than before to the nutrition, health, and education of children of preschool age in low-income families. One basis for this, in addition to mortality and morbitity studies indicating high vulnerability at that age (*1*), is information suggesting that obstacles to normal development in the first years of life, found in environments of such poverty that physical growth is retarded through malnutrition, are likely also to retard intellectual development permanently if early remedial action is not taken (*2*). The loss of intellectual capability, broadly defined, is viewed as especially serious because the technological character of contemporary civilization makes individual productivity and personal fulfillment increasingly contingent upon such capability. In tropical and subtropical zones of the world between 220 and 250 million children below 6 years of age live in conditions of environmental deprivation extreme enough to produce some degree of malnutrition (*3*); failure to act could result in irretrievable loss of future human capacity on a massive scale.

Although this argument finds widespread agreement among scientists and planners, there is uncertainty about the effectiveness of specific remedial actions. Doubts have been growing for the past decade about whether providing food, education, or health care directly to young children in poverty environments can counteract the myriad social, economic, and biological limitations to their intellectual growth. Up to 1970, when the study reported here was formulated, no definitive evidence was available to show that food and health care provided to malnourished or "at risk" infants and young children could produce lasting increases in intellectual functioning. This was so in spite of the ample experience of medical specialists throughout the tropical world that malnourished children typically responded to nutritional recuperation by being more active physically, more able to assimilate environmental events, happier, and more verbal, all of which would be hypothesized to create a more favorable outlook for their capacity to learn (*4*).

In conferences and publications emphasis was increasingly placed upon the inextricable relation of malnutrition to other environmental factors inhibiting full mental development of preschool age children in poverty environments (*5*). It was becoming clear that, at least after the period of rapid brain growth in the first 2 years of life, when protein-calorie malnutrition could have its maximum deleterious physiological effects (*6*), nutritional rehabilitation and health care programs should be accompanied by some form of environmental modification for children at risk. The largest amount of available information about the potential effects of environmental modification among children from poor families pertained to the United States, where poverty was not of such severity as to make malnutrition a health issue of marked proportions. Here a large literature showed that the low intellectual performance found among disadvantaged children was environmentally based and probably was largely fixed during the preschool years (*7*). This information gave impetus to the belief that direct treatments, carefully designed and properly delivered to children during early critical periods, could produce large and lasting increases in intellectual ability. As a consequence, during the 1960's a wide variety of individual, research-based preschool programs as well as a national program were developed in the United States for children from low-income families (*8*). Several showed positive results but in the aggregate they were not as great or as lasting as had been hoped, and there followed a widespread questioning of the effectiveness

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