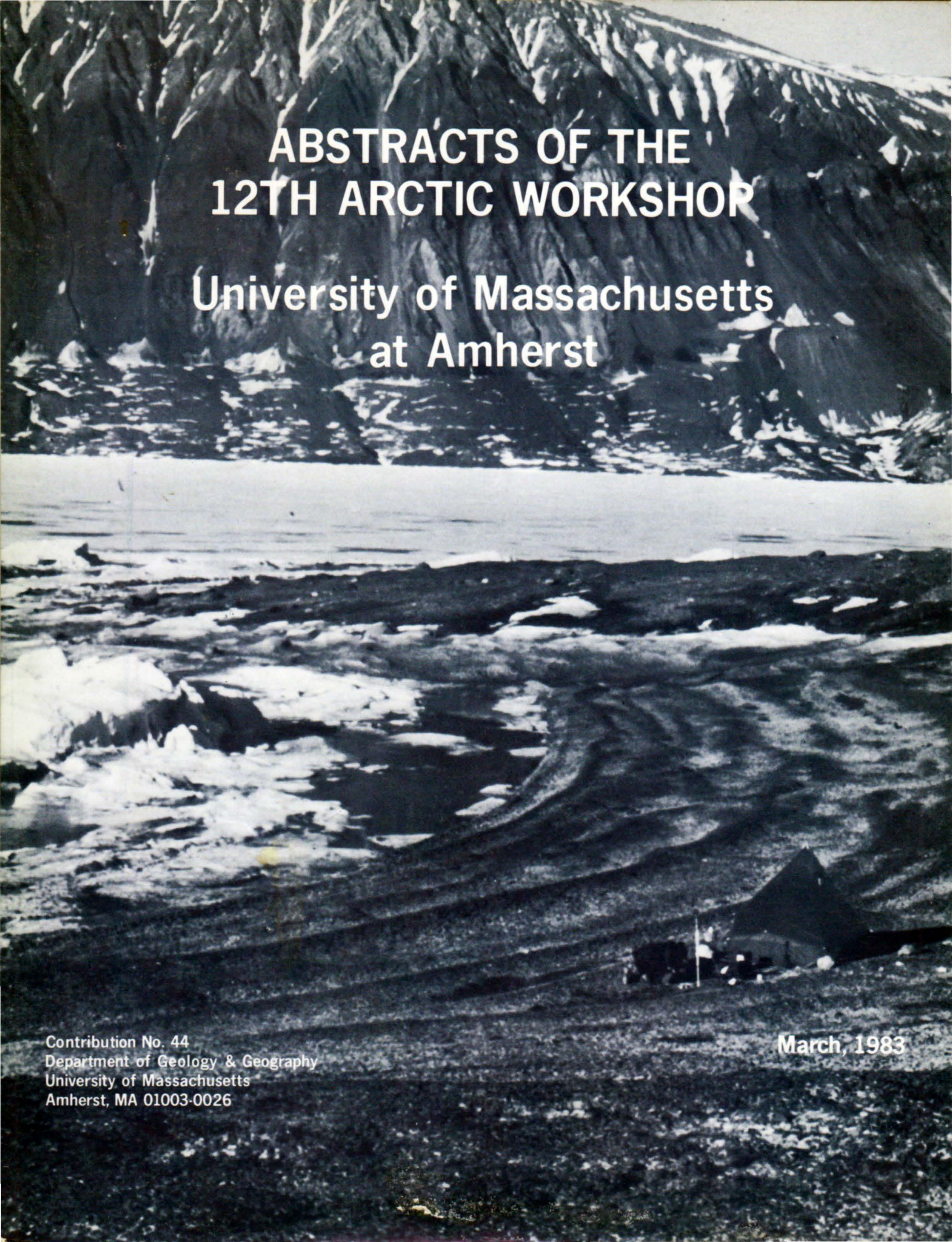


ABSTRACTS OF THE 12TH ARCTIC WORKSHOP

University of Massachusetts at Amherst

Contribution No. 44
Department of Geology & Geography
University of Massachusetts
Amherst, MA 01003-0026

March, 1983

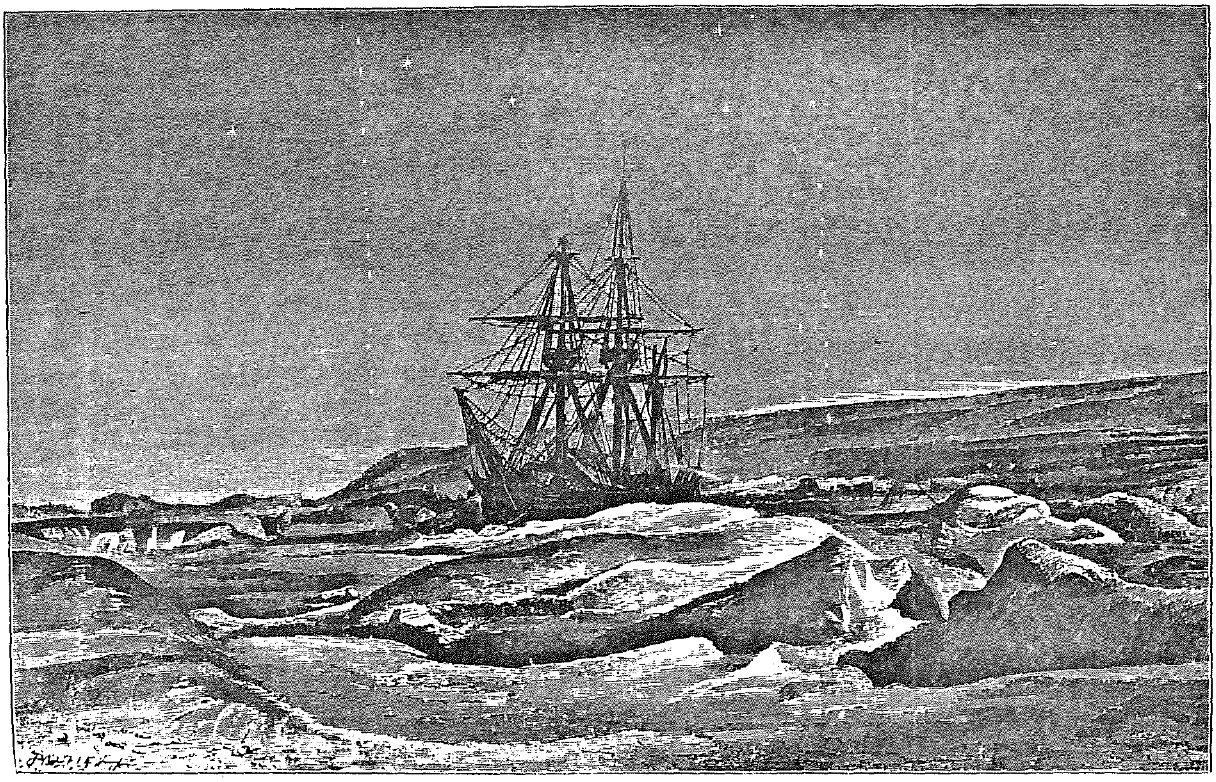
ABSTRACTS OF THE

12TH ANNUAL ARCTIC WORKSHOP

MARCH 16, 17, and 18th, 1983

UNIVERSITY OF MASSACHUSETTS

AMHERST



WINTER QUARTERS H.M.S. "ALERT."

To face p. 175.

From The Great Frozen Sea, A.H. Markham (London) 1878

12th ANNUAL ARCTIC WORKSHOP

March 16, 17, 18, 1983

AGENDA

Session A, Wednesday, March 16 - Chairman, Ray Bradley

9:00-9:30 am	*	William Barr, Dept. of Geography, University of Saskatchewan, Saskatoon Pioneer geomorphological investigations from the First International Polar Year, 1882-1883.
9:30-10:00 am		Peter Clark, Institute of Arctic and Alpine Research, University of Colorado, Boulder Onshore-offshore correlations of glacial events in Northern Labrador, Part I: the land record.
10:00-10:30 am		Heiner Josenshans, Atlantic Geoscience Center, Bedford Institute of Oceanography, Dartmouth, Nova Scotia Onshore-offshore correlations of glacial events in Northern Labrador, Part II: the marine record.
10:30-11:00 am		Coffee Break

Session B — Chairman, John Hollin

11:00-11:30 am	Detmar Schnitker, Dept. of Geological Sciences and Program in Oceanography, University of Maine, Orono The Norwegian-Greenland Sea: a critical area for global oceanography and climate.
11:30-12:00 am	S. Lehman, S. Forman and G.H. Miller, Institute of Arctic and Alpine Research, University of Colorado, Boulder Quaternary stratigraphy and ice limits, Forlandsund region, West Spitsbergen, Svalbard.
12:00-12:30 pm	G. Jones, Lamont-Doherty Geological Observatory, Palisades, New York A revised time-scale for Late Pleistocene sediments of the Central Arctic Basin: implications for understanding Arctic response to solar insolation variations.
12:30-1:30	LUNCH

*All presentations will be given in Campus Center Room 163/164.

Wednesday, cont.

Session C		Chairman, Joe Harsthorn
	1:30-2:00 pm	John England, Dept. of Geography, University of Alberta, Edmonton Isostatic adjustments in a full glacial sea.
	2:00-2:30 pm	Mike Retelle, Dept. of Geology and Geography, University of Massachusetts, Amherst Glacial geology and Quaternary marine stratigraphy, northeastern Ellesmere Island, N.W.T., Canada.
	2:30-3:00 pm	Jan Bednarski, Dept. of Geography, University of Alberta, Edmonton Glacier fluctuations and sea level history of Clements Markham Inlet, Ellesmere Island, N.W.T., Canada.
	3:00-3:30 pm	Coffee Break
Session D		Chairman, Bill McCoy
	3:30-4:00 pm	Rhodes Fairbridge, Dept. of Geological Sciences, Columbia University, New York Rising sea level and glacier surge.
	4:00-4:30 pm	Leah Haworth, Parker Calkin, Beth Lamb and James Ellis, Dept. of Geological Sciences, SUNY, Buffalo Holocene glacier variations across the Central Brooks Range, Alaska.

Session E, Thursday, March 17 - Chairman, Bill Barr

9:00-9:30 am	Gordon Jacoby, Linda Ulan and Edward Cook, Lamont-Doherty Geological Observatory, Palisades, New York Summer degree days in Alaska since 1574.
9:30-10:00 am	Richard Haugen, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire Spatial variation of mean annual air temperature in Central and Northern Alaska.
10:00-10:30 am	Ray Bradley, Dept. of Geology and Geography, University of Massachusetts, Amherst Arctic precipitation-temperature relationships and the interpretation of ice core isotopic records.
10:30-11:00 am	Coffee Break

Thursday, cont.

Session F	Chairman, Larry Williams
11:00-11:30 am	Henry Diaz, NOAA/ERL Boulder, Colorado A Comprehensive Climatic Data Set for climatic studies in northern North America.
11:30-12:00 pm	M. Kelly and T. Holt, Climatic Research Unit, University of East Anglia, U.K. Cryospheric Impact of large-scale water transfers in the USSR.
12:00-12:30 pm	J. Gavin and G. Kukla, Lamont-Doherty Geological Observatory, Palisades, New York Recent Spring Warmth in North America along the snowline.
12:30-1:30 pm	LUNCH
1:30-4:00 pm	POSTER SESSION, Campus Center Rooms 162/175
4:00 pm	Special Five College Lecture: Dr. Maurice Haycock

Session G, Friday, March 18 - Chairman, Mick Kelly

9:00-9:30 am	William Brice, Geology and Planetary Science, University of Pittsburgh, Johnstown Ralph Stockman Tarr and the Arctic.
9:30-10:00 am	P.E. Burns, Leah Haworth, Parker Calkin and James Ellis, Dept. of Geological Sciences, SUNY, Buffalo Glaciology of Grizzly Glacier, Brooks Range Alaska.
10:00-10:30 am	Mark Serreze and Ray Bradley, Dept. of Geology and Geography, University of Massachusetts, Amherst Topoclimatic studies of a small plateau ice cap, northern Ellesmere Island, N.W.T., Canada.
10:30-11:00 am	Coffee Break

Session H	Chairman, W. Patterson
11:00-11:30 am	B.M. Bergsma*, J. Svoboda*, and B. Freedman**, Botany, *Dept. of Botany, University of Toronto, Mississauga and **Biology Dept., Dalhousie University, Halifax, N.S. Retreating glacier at Ellesmere Island, N.W.T. releases an intact pre-Little Ice Age plant community.

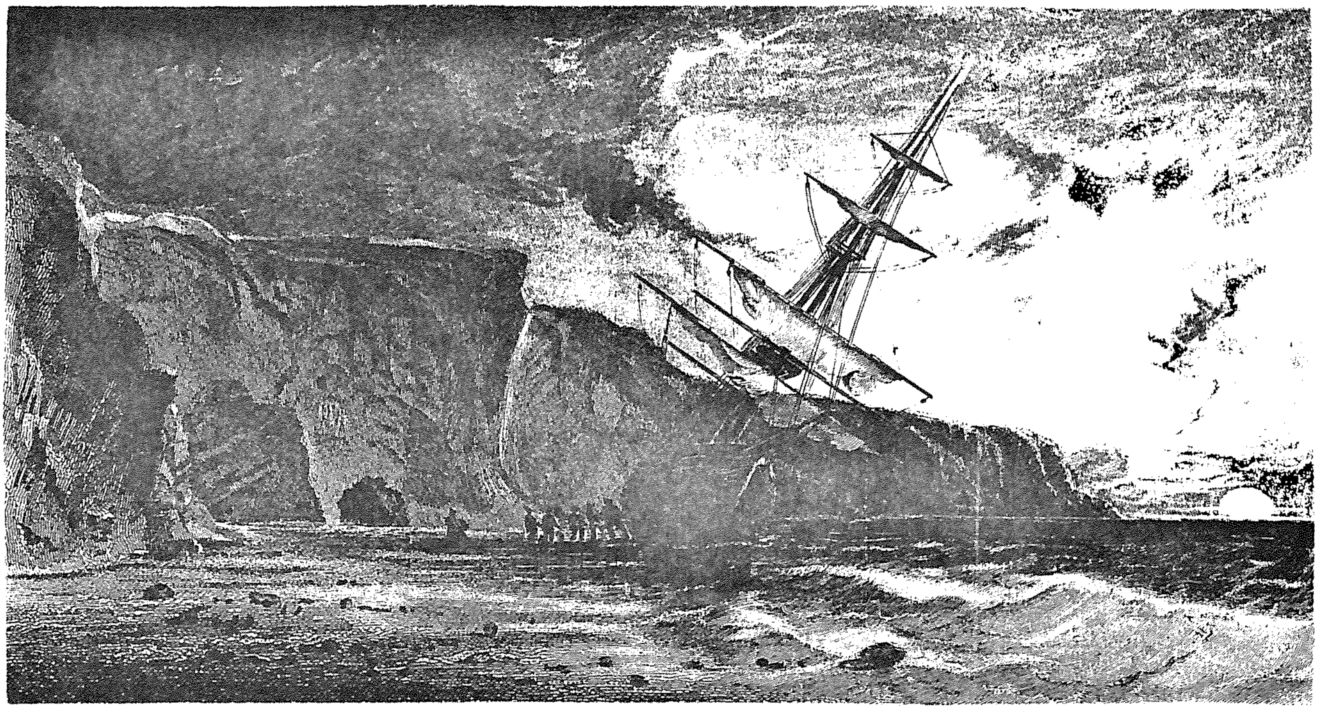
Friday, cont.

Session H cont.

11:30-12:00 pm	Sylvia Edlund, Terrain Sciences Division, Geological Survey of Canada, Ottawa Bioclimatic zonation in the Central Queen Elizabeth Islands, Canada.
12:00-12:30 pm	Anne Marie Hine, Forestry and Wildlife Management, University of Massachusetts, Amherst Fire regime: a 2000 year record of tundra fire occurrence for the Tulugak Lake Area of the Noatak Biosphere Reserve, Alaska.
12:30-1:30 pm	LUNCH

Session I	Chairman, Ray Bradley
1:30-2:00 pm	David R. Foster, Limnological Research Center Univ. of Minneapolis, Minnesota Patterns of post-fire vegetation development in southern Labrador
2:00-2:30 pm	William A. Patterson III, Brayton F. Wilson and John F. O'Keefe, Forestry and Wildlife Management, University of Massachusetts, Amherst The Ecology of Alder (Alnus viridis Furlow) at its range limit in Northwest Alaska.
2:30-3:00 pm	James C. Ritchie, Life Sciences, Scarborough College, University of Toronto Aspects of the post-glacial vegetation dynamics of the Northwest.
3:00-3:30 pm	Coffee Break
3:30-4:00 pm	Robert E. Ackerman, Dept. of Anthropology, Washington State University, Pullman, Late Pleistocene-Early Holocene hunting complexes of southwestern Alaska.
4:00-4:30 pm	P.T. Davis, Geology, Mount Holyoke College, Ma. Large Geomorphic Events, Pangnirtung Pass, Baffin Island, Summer 1981.
4:30-5:00 pm	Daniel Lawson, Cold Regions Research & Engineering Laboratory, Hanover, New Hampshire Effects of disturbance on ice-rich perennially frozen terrain

FIVE COLLEGE LECTURE



ARCTIC MEMORIES

EARLY EXPLORATION OF THE NORTH AMERICAN ARCTIC AND RECOLLECTIONS OF TRAVELLING AND PAINTING HISTORICAL SITES FOR OVER HALF A CENTURY.

DR. MAURICE HAYCOCK

CAMPUS CENTER ROOM 164

THURSDAY, MARCH 17TH: 4P.M.

ABSTRACTS OF PAPERS & POSTERS

Pioneer geomorphological observations from the First International Polar Year, 1882-1883

William Barr
Geography,
University of Saskatchewan, Saskatoon

This year marks the centennial of the First International Polar Year, 1882-83, which represented a landmark in international scientific co-operation in the polar regions. Conceived by Lieutenant Karl Weyprecht of the Austro-Hungarian Navy and co-ordinated by an International Polar Commission, chaired by Professor H. Wild of the Chief Physical Observatory in St. Petersburg, this international program saw 14 major expeditions dispatched by 11 different countries to the polar regions.[1] Of these 12 were located in a circumpolar ring in the northern hemisphere; two were in the southern hemisphere, at South Georgia and Cape Horn.

Although the major foci of the research efforts of all the stations were meteorology, terrestrial magnetism and auroral studies, and geomorphology was not a component of the official program, several expedition members produced very perceptive descriptions of geomorphological phenomena, particularly in terms of periglacial features; in several cases these observers presented hypotheses as to the formation of these features which are remarkably close to those which have subsequently (and independently) become accepted as to their formation.

Thus, for example, Dr. K. R. Koch,[2] who mounted the German one-man auxiliary expedition to the Labrador coast, argued on the basis of the sharp contrast between the shattered felsenmeer of the upper slopes, and the heavily glaciated forms of the lower slopes, that the higher peaks of the Torngat Mountains had escaped glaciation.

From the Lena Delta Dr. A. Bunge,[3] a member of the Russian expedition to Ostrov Sagastyr' wrote a fine description of tundra polygons and ascribed their formation to thermal contraction cracking followed by progressive ice wedge growth. From the same general area he also described in detail rapid coastal erosion due to thermal abrasion of ice-rich sediments, while from the southwestern corner of the Delta he presented a thorough description of pingos, but erroneously explained them as being fluvial erosion residuals. From the other Russian station at Malyye Karmakuly on Novaya Zemlya one of the observers, N. Krivosheya[4] has described what are obviously sorted polygons; in attempting to explain them, however, he ascribes a major role to eluviation of the fines by meltwater from the coarse borders.

One of the German stations was located on Clearwater Fiord, Baffin Island.[5] Here one of the observers, Dr. H. Abbes,[6] described and explained severe frost shattering of granite bedrock at the lip of a small hanging valley by the small stream emerging from that valley.

Finally the scientists of the Dutch expedition, whose ship *Varna* was prevented by ice from reaching her destination at Dikson at the mouth of the Yenisey but instead drifted around, beset in the ice of the Kara Sea for the entire year, recorded the presence of submarine permafrost throughout the southwestern part of that sea. A total of 46 sea water temperature profiles was compiled throughout the winter as the ship drifted.[7] In every case the water temperature at the sea bed was negative, varying between −0.8° and −1.8°C. Although the Dutch scientists made no comment on the phenomenon, they had in fact produced what is almost certainly the earliest record of submarine permafrost.

References

1. Baker, F. W. G. 1982. The First International Polar Year, 1882-83. *Polar Record* 21(132):275-285.
2. Neumayer, G. (*ed.*). 1891. *Die deutschen Expeditionen und ihre Ergebnisse*. Band I. Geschichtlicher Theil. Berlin: A. Asher & Co.
3. Bunge, A. 1895. Opisaniye puteshestviya k ust'yu r. Leny, 1881-1884. Appendix to: Tillo, A. A. *ed. Trudy russkoy polyarnoy stantsii na ust'ye Leny*, Part I. St. Petersburg: Imperatorskoye Russkoye Geograficheskoye Obshchestvo, pp. 1-96.
4. Krivosheya, N. 1886. Novaya Zemlya. Putevya zametki iz polyarnoy ekspeditsii 1882-83 godov. *Vestnik Yevropy* 4(7):75-125; 4(8):469-514.
5. Barr, W. and C. Tolley. 1982. The German expedition at Clearwater Fiord, 1882-83. *The Beaver* 313(2):36-45.
6. Abbes, H. 1884. Die deutsche Nordpolar-Expedition nach dem Cumberland-Sunde. *Globus* 45:294-298; 312-315; 328-331; 343-345; 365-368.
7. Snellen, M. and H. Ekama. 1910. *Rapport sur l'Expédition Polaire Néerlandaise qui a hiverné dans la Mer de Kara en 1882/83*. Utrecht: J. Van Boekhoven.

Wm. Whisler, Died May 24. — W. A. Ellis, Died May 19. — J. Bender, Died June 16. — Sergt. Cross, Died Jan. 1. — Sergt. Fredericks, Rescued. — Sergt. Linn, Died Apr. 6. — Henry Biederbeck, Rescued. — Chas. B. Henry, Died June 6. — Sergt. Long, Rescued. — Sergt. Ralston, Died May 23. — Corporal Salor, Died June 3. — Sergt. Gardner, Died June 12. — Sergt. Ellison, Died July 6. — Dr. Pavy, Died June 6.

Maurice Connell, Rescued. — Sergt. Brainard, Rescued. — Lieut. Kislingbury, Died June 1. — Lieut. Greely, [illegible] — Lieut. Lockwood, [illegible] — Sergt. Israel, Died May 27. — Sergt. Jewell, Died Apr. 12. — Sergt. Rice, Died Apr. 9.

Sailed from St. Johns, Newfoundland, July 7, 1881, on the Steamship Proteus.

GREELY ARCTIC EXPEDITION.

Rescued from Camp Clay, near Cape Sabine, in Smith's Sound, June 22, 1884.

[illegible] EXPEDITION.

THETIS,— Commander Winfield S. Schley. Sailed from New York, May 1, 1884.

BEAR, [illegible] Sailed from New York, [illegible]

ALERT,— Commander George W. Coffin. Sailed from New York, May 10, 1884.

Glacier Fluctuations and Sea Level History, Clements Markham Inlet, Ellesmere Island

Jan Bednarski
Dept. of Geography
The University of Alberta
Edmonton, Alberta

Clements Markham Inlet, a major reentrant on the northernmost coast of Ellesmere Island, is bounded on three sides by upland ice caps. Low lying areas at the head of the Inlet are presently ice-free and characterized by extensive raised marine deposits. Detailed field work and mapping provides a scenario of former glacier behavior, especially the pattern of ice retreat from confluent positions at the head of the Inlet. Over 40 radiocarbon dates are used to develop a chronology and construct emergence curves.

High level ice marginal channels and mountain summit erratics indicate a penultimate glaciation which flowed unconstrained by local topography. In contrast, the most recent glaciation was comprised of confluent trunk glaciers occupying only the low lying areas at the head of the Inlet. Valley mouths along the sides of the Inlet were occupied by smaller glaciers which debouched into the sea.

The stratigraphy at the head of the Inlet indicates a rapid marine transgression following the retreat of a well grounded glacier. Conversely, the sections at the mouths of side valleys, further down the Inlet, show interaction of glacigenic and marine sediments indicating proximal ice front conditions.

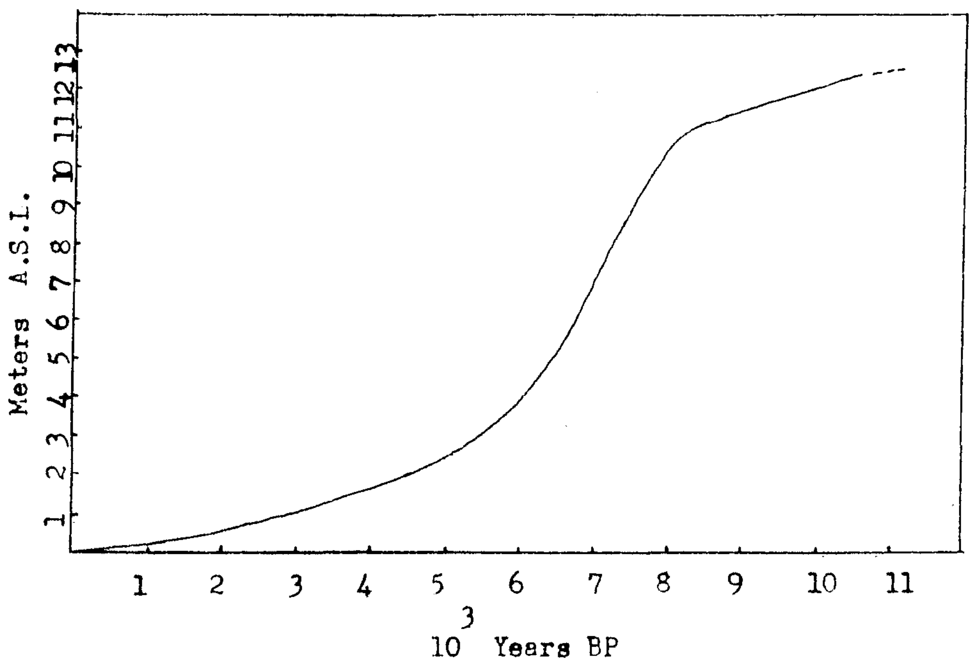
The greater part of the Inlet was ice free before 10,690 BP. Some ice margins were within 7 km of their present positions by ca. 9.7Ka BP. The mouths of the confluent valleys at the head of the Inlet did not become ice free until ca. 8 Ka BP.

Individual strandlines tilt up toward the present ice caps on the Grant Land Mountains, suggesting the isobases trend parallel to the outer coastline. The highest relative sea level tilts from 92 m asl at the outer coast, to 124 m asl near the head of the Inlet, a distance of 35 km.

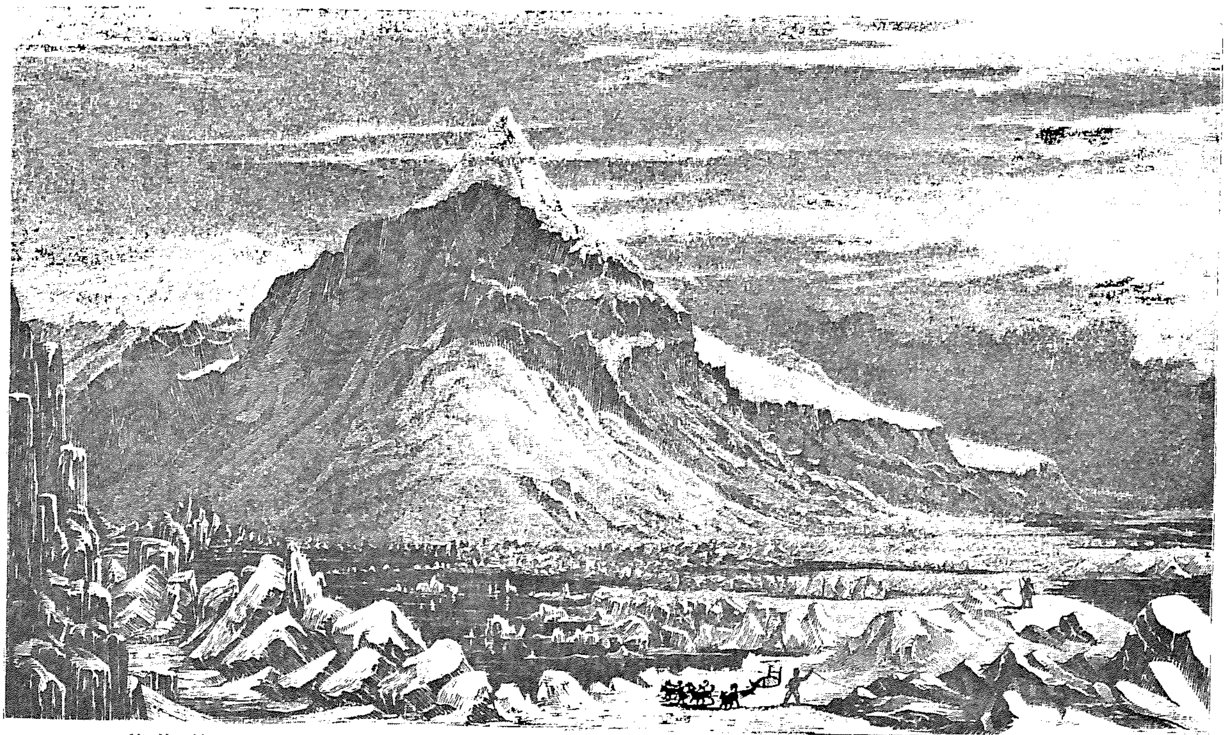
Relative sea level curves show a near stable, or slowly emerging sea at ca. 11 Ka BP, after which emergence follows a "normal" deglacial pattern.

Three lines of evidence suggest that the 11 Ka BP ice position within the Inlet was probably the maximum extent during the last glacial cycle. First, the near stable nature of the high relative sea suggests that rapid ice load changes were not taking place until 8 Ka BP. In fact, stable relative seas would be expected in the zone of isostatic depression beyond the maximum extent of the last glaciation. Second, stratigraphic evidence suggests that inflowing glaciers near the landward limit of the uppermost

sea were calving into the sea, and not merging with a major fiord glacier. Lastly, the oldest dates collected are found near the head of the Inlet, not at the outer coast as would be expected should a fiord glacier be retreating up the Inlet.



Emergence Curve for the Inner Part of Clements Markham Inlet.



THE SHORES OF THE POLAR SEA.

(FROM A SKETCH BY DR. HAYES.)

From The Open Polar Sea, I.I. Hayes (N.Y.) 1867

Retreating glacier at Ellesmere Island N.W.T. releases an intact pre-Little Ice Age plant community

Bergsma[1], B.M., J. Svoboda[1] and B. Freedman[2]

[1]Botany, University of Toronto, Erindale Campus, Mississauga, Ont.

[2]Biology, Dalhousie University, Halifax, N.S.

The release of a dead plant community, buried for at least 400 years under glacial ice at Alexandra Fiord on central Ellesmere Island (79°N) is reported. Remarkably intact plants have been emerging from the ablating front of a retreating polar glacier for several decades. The vegetation can be readily recognized as a *Cassiope tetragona*-*Dryas integrifolia* dominated community, similar in species composition and cover to an extent *Cassiope*-*Dryas* community 200m below the ablation front. The excellent preservation of the plants is attributed to the likelihood that polar glaciers are frozen to their base, and hence their movements are by internal deformation rather than by erosive basal sliding. Reinvasion of a new community and its development with the passage of time was studied and described as a primary succession. The authors found only one reference describing similar discovery. Goldthwait (1956) reported boulders covered with 200 year-old moss on the bed of a glacial ice tunnel near Thule, Greenland.

At the southern apex of Alexandra Fiord lowland two outlet glaciers descend from south and west into the valley deglaciated several thousand years ago. Both of these glaciers show signs of recession which has been in progress for several decades. The western tongue has retreated almost 100 m and separated itself from its former juction with the southern partner as documented on an aerial photograph from 1959. This modern retreat of the two glaciers has been attributed to the delayed response to recent climatic amelioration which began in the late 18th century after termination of the "Little Ice Age" period.

The recent retreat is obvious from the light-coloured zone around the glacial terminus which is in sharp contrast with the older deglaciated landscape covered with dark saxicolous and terricolous lichens. Direct measurements showed a meltback of 5.6 ± 0.8 in y^{-1} in 1981 and 5.9 m y^{-1} in 1982.

Many of the released plants were in remarkably good condition. Deciduous shrubs *Vaccinium uliginosum* (arctic blueberry) and *Salix arctica* (arctic willow) had foliage still attached. Cushions of *Dryas integrifolia* (mountain avens) had intact flower heads and plumous seeds. Seed viability tests were, however, unsuccessful. Foliage of *Cassiope tetragona* (arctic white heather), *Dryas* and moss *Rhacomytrium lanuginosum* appeared to be still green and spectrophotometric analysis confirmed remanants of chlorophyll. - Radiocarbon dating determined the age of two uncovered specimens of *Cassiope* and *Salix* to be 400 ± 140 y and 430 ± 90 y B.P. thus supporting the pre-LIA origin hypothesis of the released community.

A detailed picture of the old and new vegetation pattern was constructed by recording the plant occurrence and cover from the glacial margin to the outermost ground moraine, along a transect set out as a very long, narrow rectangle (20 x 232 m). In this corridor the dead plant community cover diminished (due to weathering and erosion after release) with the distance from the glacial margin, while the new, live community increased in cover percentage and species diversity going away from the ice (Figure 1).

Reference: Goldthwait, R.P. 1956. Snow Ice Permafrost Research Establishment Tech. Rep. 39:139-150.

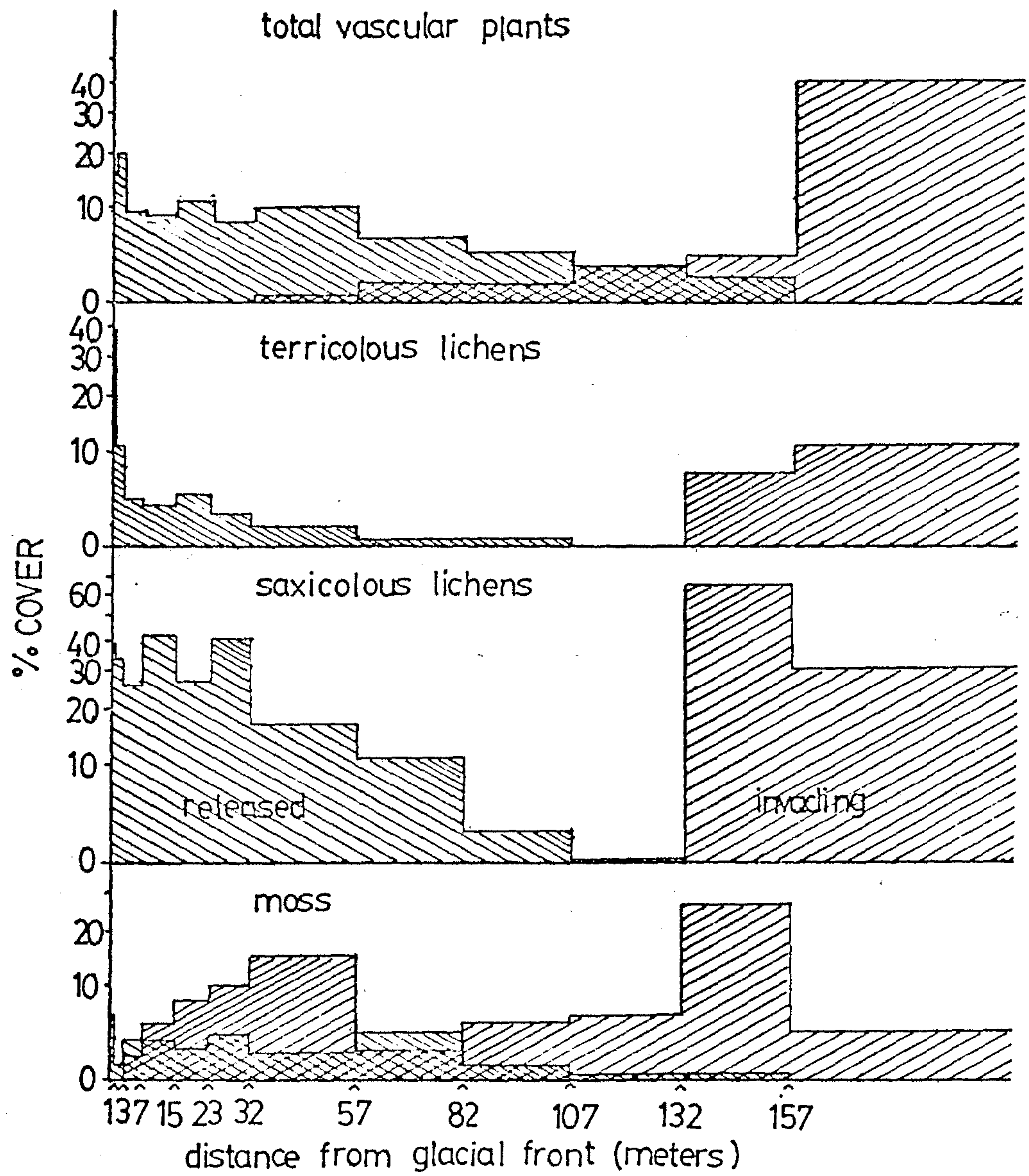


Figure 1. Mean % cover of released and invading mosses, lichens and vascular plants along a succession transect of the western glacier.

Arctic Precipitation-Temperature Relationships and the Interpretation of Ice Core Isotopic Records

Raymond S. Bradley

Geology and Geography, University of Massachusetts, Amherst

One of the most important sources of paleoclimatic data is ice cored from polar ice caps and ice sheets. Ice cores contain a wide variety of information (volcanically-induced acidity variations, atmospheric gaseous composition changes, turbidity fluctuations, atmospheric pressure at original depositional sites, etc.) but the major parameter measured in all cores is the oxygen isotopic composition ($\delta^{18}O$). Based on work by Dansgaard (1964) and empirical studies by Dansgaard et al. (1975) $\delta^{18}O$ is considered to reflect mean annual temperatures. However, this is not a physically meaningful correlation. Arctic precipitation occurs on very few days of the year and since the isotopic composition depends on the temperature of formation of the precipitation (amongst other factors) a correlation with mean annual temperatures is not a useful calibration for paleoclimatic purposes. Analysis of modern climatic data for arctic stations leads to important conclusions regarding ice core isotopic records. At Alert, for example, 80% of all precipitation results from precipitation events ≥ 1 mm which occur on only 22% of days. Similarly at Thule, 73% of all precipitation results from precpitation events ≥ 1 mm which occur on less than 10% of days. Thus, temperatures of 'precipitation days' not mean annual temperatures must be more relevant to ice core isotopic records. The mean temperature of precipitation days in most months is significantly higher than days with no precipitation; further, in certain months, there is a positive correlation between daily precipitation amounts and mean daily temperatures. This suggests that lower $\delta^{18}O$ values (corresponding to lower temperatures) in ice core records should be accompanied by less precipitation. For example, higher $\delta^{18}O$ values such as occurred at the beginning of the Holocene could be partly due to higher temperatures and accompanying higher precipitation. These considerations are examined in relation to ice core istopic records and other paleoclimatic indices from Greenland and the Canadian High Arctic.

References

Dansgaard, W. 1964. Stable isotopes in precipitation. Tellus, 16, 436-468.

Dansgaard, W., Johnsen, S.J., Clausen, H.B. and Gundestrup, N. 1975. Stable Isotope Glaciology. Meddelelser øm Gronland, 197, 1-53.

Ralph Stockman Tarr and the Arctic

William R. Brice
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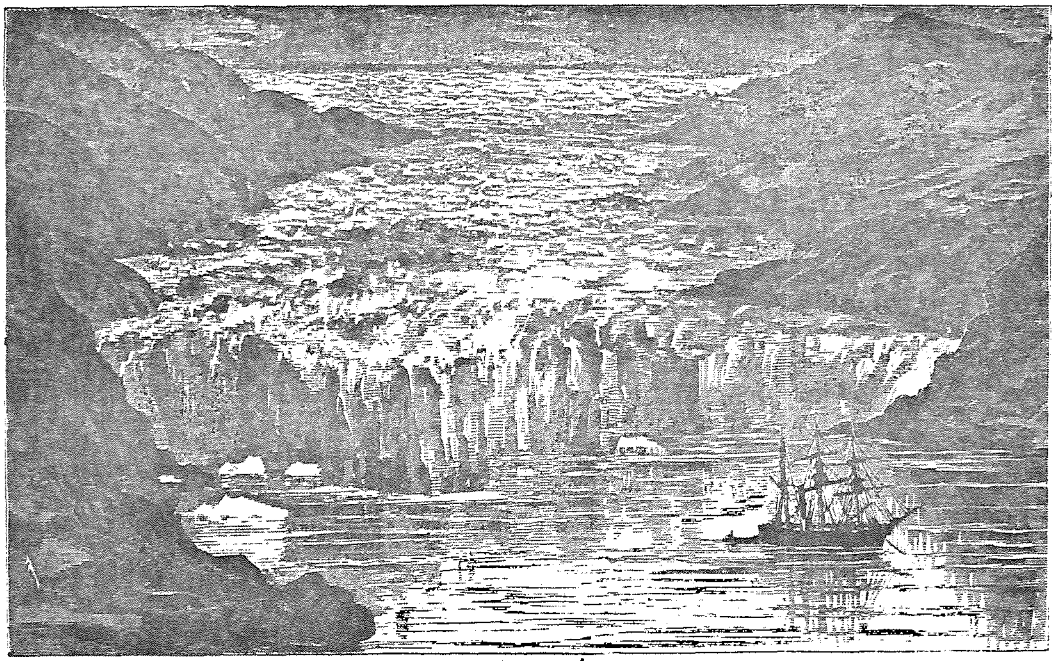
University of Pittsburgh at Johnstown
Johnstown, PA 15904

In the late nineteenth and early twentieth centuries R. S. Tarr of Cornell University led several expeditions into the Arctic regions to study glaciers and the effect of glaciation on the landscape. In turn, Tarr applied what he saw and learned from his Arctic studies to his investigations of the landscapes in the Finger Lake Region of New York State and parts of New England.

Tarr made his first trip into the Arctic as part of the 1896 Peary Expedition. He was the leader of a small party of geologists from Cornell who explored the Upper Nugsuak Peninsula and Disco Island. The Cornell Glacier, a small distributary glacier of the Greenland Ice Sheet, is a legacy of this 1896 expedition. Here they found evidence of the former extensions of the ice cap, and strong indications that the ice had actually overridden an area and still left sharp peaks in place. In an attempt to get direct measurements of the ice movement, Tarr left a note under a rock cairn in which he indicated the location of the glacier margin. Over thirty years after Tarr's untimely death in 1912, the note was found by another field party.

After the turn of the century, Tarr turned his attention to Alaska. Under the sponsorship of the U.S.G.S. and the National Geographic Society, Tarr led expeditions to the Yakutat Bay Region in 1905, 1906, 1910, and 1911. From these labors came numerous small papers and two U.S.G.S. Professional Papers #'s 64 and 69 (co-authored with Lawrence Martin). In addition he and Martin produced the large National Geographic volume on the Alaskan Glacier Studies (published after Tarr's death). This was the same region of Alaska that G. K. Gilbert had visited in 1899 as part of the famous Harriman Expedition, so Tarr was able to compare the conditions and locations of the glaciers as he found them with the descriptions of Gilbert. He found that in 1905 several glaciers showed evidence of massive surges since Gilbert's visit. This prompted him to undertake a long term study as to the cause of this surge by making careful surveys of the ice masses in subsequent years. Tarr finally related the ice surges to a large earthquake that struck the area shortly after Gilbert's visit.

At the time of his death in 1912 Tarr was actively engaged in experimental studies into glacial movement.



THE GLACIER OF SERMITSIALIK.

I TRUST that I have made plain, even to the least scientific of my readers, the nature of the glacier which we are visiting, as well as the general principles of glacier formation and movement. Why ice, a solid, firm substance, should move in obedience to the same laws which govern the movements of fluids; why, for instance, a glacier should, like a river, move more rapidly at its centre than near its banks, is a question which the wisest philosophers have sufficiently discussed without my attempting it here. Taking the fact for granted, and knowing that the vast reservoir of ice in the interior of Greenland is the great source of supply to all the glaciers that pour to the sea through the mountain-passes, we may here, I think, not inappropriately, pause a little to watch the progress of this glacier of Sermitsialik.

Even within the period of a generation it has undergone very perceptible changes. Peter Motzfeldt has told me that fifty years ago he walked across the valley in front of it, and plucked whortleberries upon the identical spot where I had gone into the ice-cavern to hear the waters rushing to the sea. He pointed out to me the line of the glacier front at that time, so far as he could remember it (and the memory of such men is apt to be accurate); and, accepting his memory as correct, the movement of the glacier from that time to the present has been about seven (7) inches daily, the distance being a fraction over two miles.

From <u>The Land of Desolation</u>, I.I. Hayes,

(New York) 1872.

Glaciology of Grizzly Glacier, Brooks Range, Alaska.

Phillip E. Burns, Leah A. Haworth, and Parker E. Calkin
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An ongoing study of Grizzly Glacier, a small subpolar cirque glacier in the central Brooks Range at 68° N, reveals a reversal in 1982 of a half decade of cooling temperatures and lowering equilibrium line altitudes (ELA). This north-facing glacier, located near the trans-Alaskan oil pipeline, has been under observation since 1977 as part of an investigation into Holocene glacier activity throughout the Brooks Range. Grizzly Glacier, at a mean altitude of 1780 m, receives about 550 mm precipitation annually, half of which is snow that is supplemented by avalanching and drifting. The mean annual temperature at nearby Atigun Pass is -14°C and July temperatures at the glacier average about 3.1°C. Grizzly Glacier has an area today of 0.14 km^2, a 60% reduction since its Neoglacial maximum.

From 1977 to 1981 Grizzly Glacier experienced increasing net balances and an ELA drop of 250 m to elevations near the present-day snout. This drop is of about the same magnitude as that computed between the Neoglacial maximum and those ELA's apparently more characteristic of the twentieth century[1]. In 1982 the cooling trend was reversed with average July temperature rising from 1.6°C (in 1981) to 4.3°C accompanied by an ELA rise of 70 m to near the upper edge of the glacier. The resulting net balance was -.09 m H_2O for the balance year July 26, 1981 to when recording ended July 28, 1982. This is derived from a winter balance of .41 m H_2O and a minimum summer balance of .50 m H_2O. However, snow remaining at the end of the previous ablation season results in a positive net balance for the last two balance years taken together. Avalanching appears to be an important factor in the mass balance of Grizzly Glacier, adding several centimeters of snow per week to the existing accumulation in early summer and thus delaying the onset of net summer ablation.

Preliminary analyses of insolation and temperature data suggest that ablation may be more strongly related to air temperature than to solar radiation. Ground level environmental lapse rates of 0.92 to 1.4°C/100 m were calculated between Grizzly Glacier and valleys 700 m below. This represents a 50-100 percent increase over the standard adiabatic lapse rate (0.6°C/100 m) and may provide a more accurate estimate of temperatures accompanying fluctuations of Pleistocene and Neoglacial snowlines.

Reference

1. Ellis, J.M., and Calkin, P.E., 1982, 1977-1981: An interval of descending ELA's and cooling temperatures, central Brooks Range, Alaska: Geological Society of America, Abstracts with Programs, v. 14 (7), p. 483.

Onshore offshore correlation of Glacial events in Northern Labrador

Part I

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We attempt here to correlate the surficial geology of the northern Torngat Mountains with the adjacent deposits on the Labrador shelf.

In the Torngat Mountains, an early Wisconsin glaciation is indicated by the degree of soil development and amino acid ratios on shells from till (Clark, 1982). The altitude of moraines 1 km inland of the present day coastline south of Kangalaksiorvik Fjord near Iron Strand indicates a minimum ice thickness of 650 m advancing onto the continental shelf. A mid-Wisconsin retreat following this major advance is indicated by fossiliferous glaciomarine sediments at Iron Strand having an age of 30-40,000 years BP based on amino acid ratios and C^{14} ages (Clark, 1982). A late Wisconsin (Laurentide) advance appears to have been a relatively minor event which was restricted to the major valleys. At this time ice at the Ungava Bay - Labrador Sea drainage divide did not exceed 700 m in elevation and terminated at the mouth of Kangalaksiorvik Fjord. Similarly in Ryans Bay, an ice lobe advanced only as far as the head of the bay. Consequently large areas of the Torngat Mountains and coastal regions, including Iron Strand, remained unglaciated during the late Wisconsin.

Part II

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On the Labrador shelf a moraine system 25-30 km seaward of the present coastline parallels the coast from Noodleok Fjord to south of Saglek Bay. This moraine is recognized and mapped on the basis of airgun and Huntec DTS high resolution seismic reflection data. Detailed examination of these profiles suggests this moraine is the product of at least two glacial ice advances. Data acquired in 1982 suggests that these advances were less extensive laterally and significantly older than suggested by Fillon and Harmes (1982). Based on equations from Schilling and Hollin (1981) an ice sheet having a thickness of 650 m near the coast would terminate 25-30 kms offshore on the continental shelf. This, therefore, suggests a correlation with the early Wisconsin advance on land. Age determinations on samples from these marine tills are presently in progress.

Large Geomorphic Events, Pangnirtung Pass, Baffin Island, Summer 1981

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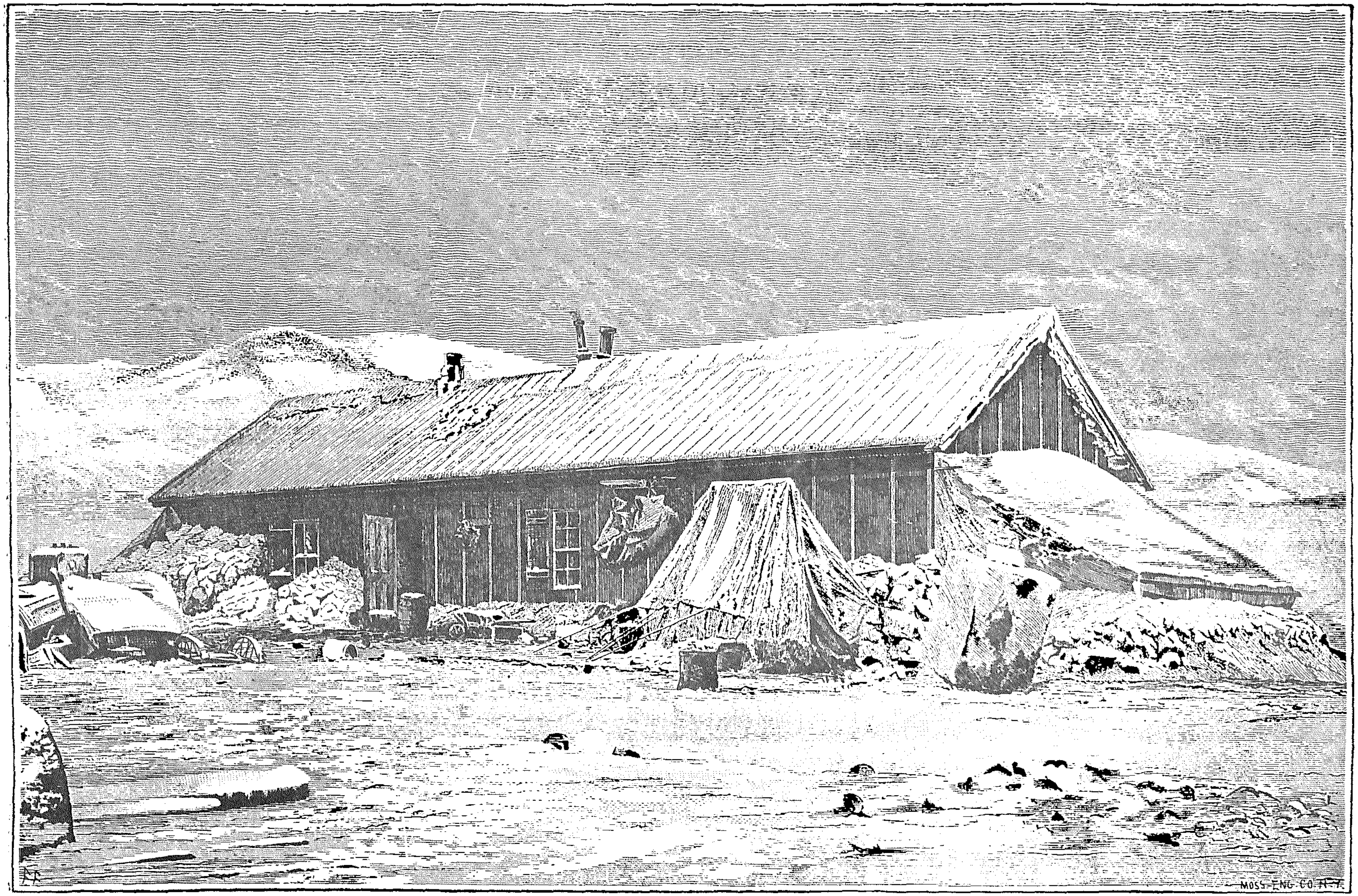
Catastrophic geomorphic events, including debris flows, rockfalls, and floods, occurred on Cumberland Peninsula during a warm, wet July and August, 1981. Floods severely damaged or destroyed all bridges that spanned meltwater streams in Auyuittuq National Park. That one rockfall littered the main thoroughfare with car-size blocks apparently went unnoticed by most passers-by. However, humans witnessed two debris flows, one which nearly engulfed the observers while doffing their boots for a stream crossing.

The two debris flows were triggered by icefalls onto sodden slopes from hanging glaciers. Both flows extended over 2 km to the Weasel River, leaving up to 3 m-high levees. The first occurred on the east side of Pangnirtung Pass, below Tirokwa Peak, on 30 July; the second on the west side of the Pass, below Odin Peak, on 13 August. Each debris flow followed within 24 hrs the warmest and wettest 3-day periods during July and August. A preliminary search on other debris-flow levees did not reveal any lichen covers and/or diameters younger than 50 yrs BP, suggesting a recurrence interval of at least 50 yrs for big debris flows in Pangnirtung Pass.

A massive rockfall occurred on the east side of Pangnirtung Pass below Sandcastle Peak sometime in early- to mid-July. Fresh impact scars on soft tundra vegetation suggested that some large equant blocks bounced over a km across the valley floor to their resting spots. The lack of older, similar rockfall debris on the floodplain suggests that the 1981 rockfall was the greatest magnitude event since deglaciation more than 8,000 yrs ago, possibly 40-100,000 yrs ago.

Some glacial meltwater streams rose 2-3 m above normal, removing heavy timber bridges which had been undisturbed for 5 years. The largest bridge in the Park, a suspension-type across a constriction in the Weasel River at the Windy Lake Neoglacial moraines, was partially destroyed on 30 July, following the heaviest rainfall of the summer. The bridge had been secure since 1976. Temporary ponding of the Weasel River occurred behind numerous constrictions around Neoglacial moraines which rest on the valley floor. Meltwater streams from side-valley glaciers created deltas along the shores of these ponds 2-3 m above normal Weasel River level. Summit Lake, at the divide of Pangnirtung Pass, rose 2 m above normal level, flooding some emergency structures built by Parks Canada.

Equilibrium Line Altitudes (ELA's) rose above 2000 m a.s.l. in the Pangnirtung Pass area by mid-August, 1981.



OUR HOUSE AT CONGER (WEST SIDE), MARCH, 1882.

(From a photograph.)

A Comprehensive Climatic Data Set for Climatic Studies in Northern North America - Description and Preliminary Results

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An extensive data set of monthly temperature and precipitation has been compiled for Alaska, Canada and Western Greenland. There are approximately 150 stations having on average a minimum of 40 years of record. About 30% of the stations have data since ~1920 or about 60 years of record. Ten percent have data from 1900 or earlier (80 years of record).

The data has been stored by parameter and by station. Canadian data, in addition to mean monthly temperature and precipitation, contains average maximum and minimum temperature and total monthly snowfall.

The monthly anomalies have been mapped onto a 2 1/2° x 10° Lat-Long grid extending northward from 45°N and between 20°-170°W.

Samples of the initial analyses of these data are presented.

Bioclimatic Zonation in the Central Queen Elizabeth Islands, Canada

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The central Queen Elizabeth Islands, in the Canadian Arctic Archipelago, are subdivided into four bioclimatic zones, based on the life-forms of the plant communities, species diversity and abundance, and a variety of indicator species such as woody plants, marsh emergents, and certain sedges, vascular cryptogams and herbs. Zone 1, a zone of extreme improverishment, has the least diversity (less than 35 vascular species); sedges, woody species, vascular cryptogams and herbs such as Geum Rossii, Leguminosae, and Compositae are absent; emergent marsh species are confined to a typical wetland species (Alopecurus alpinus). In zone 2, the total vascular plant diversity reaches up to 60 species, dwarf woody shrubs, such as Salix arctica and Dryas integrifolia, and the sedges Carex aquatillis var. stans and Eriophorum Scheuchzeri occur locally but are not major components of the plant communities. Pleuropogon Sabinei occurs locally as a marsh emergent. In zone 3, total vascular species diversity reaches up to 100; woody species are commonly the dominant vascular component of moderately to well drained materials, and numerous species of Carex and Eriophorum dominate the wetlands. Pleuropogon Sabinei and Ranunculus hyperboreus are locally common marsh emergents. Zone 4 is the richest zone in the central high arctic with more than 100 species of vascular plants; dwarf shrubs are dominant in all but the wettest sites, and species diversity is great. Herbaceous species especially Leguminaosae Compositate Graminae and Cyperaceae show great diversity, and rare species such as Cassiope tetragona, Geum Rossii and vascular cryptogams occur in this region. Marsh emergents include several Ranunculus species, and rare occurrences of Caltha palustris and Arctophila fulva.

These zones which cross lithological boundaries, establish a "mini-treeline" north of which no woody species (prostrate dwarf shrubs) occur, and a "mini-forest zone" south of which dwarf shrubs are the dominant vascular plant. This zonation occurs on latitudinal, altitudinal and local scales, as well.

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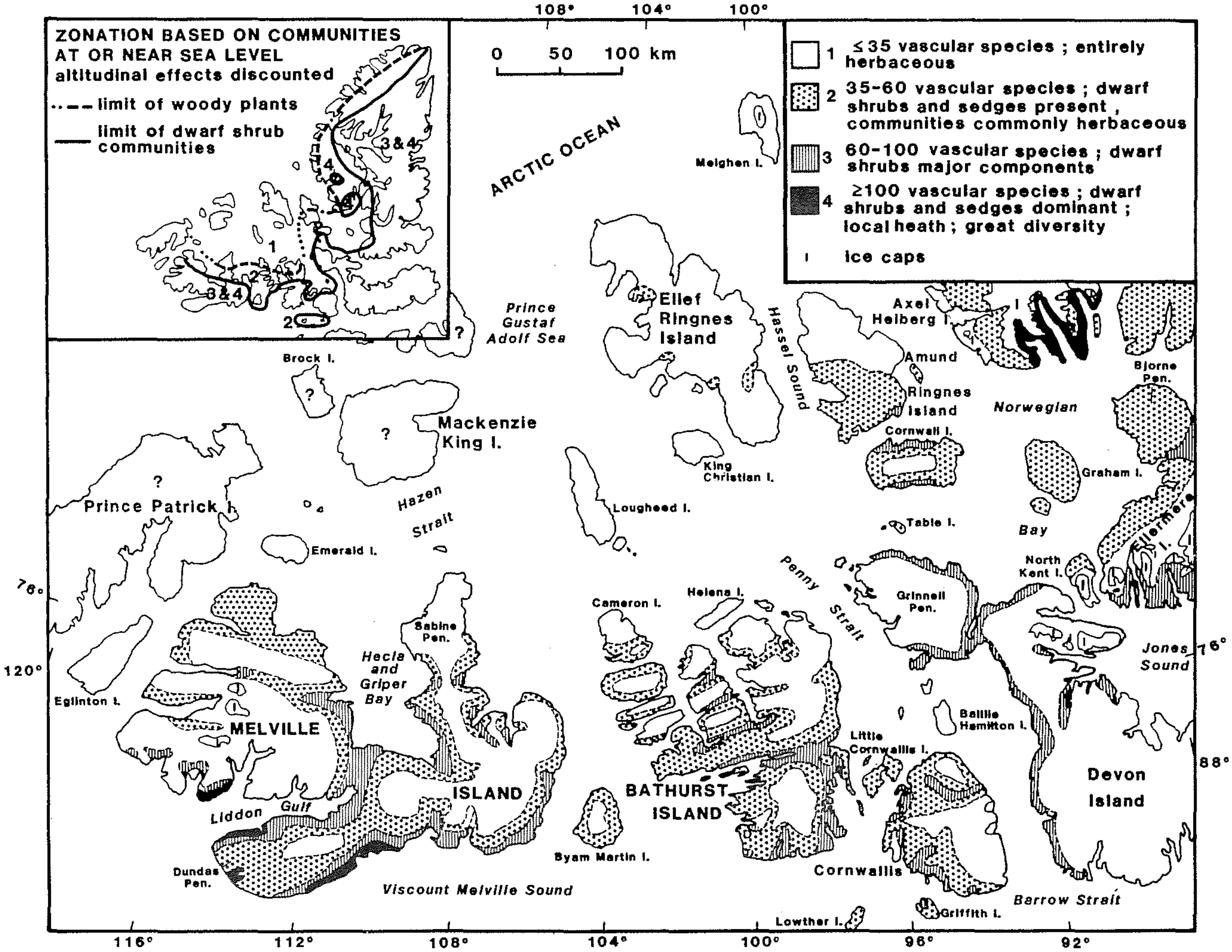

Bioclimatic zonation of the central Queen Elizabeth Islands and vicinity.

IMPLICATIONS OF A FULL GLACIAL SEA BETWEEN THE N.E. ELLESMERE ISLAND AND N.W. GREENLAND ICE SHEETS

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During the last glaciation an ice-free corridor existed between the northeast Ellesmere Island and northwest Greenland ice sheets. This corridor constituted a peripheral depression in which the marine limit marks the uppermost extent of a full glacial sea. The full glacial sea on northeast Ellesmere Island is characterized by: (1) ^{14}C dates on in situ marine shells that predate initial emergence (unloading); followed by (2) synchronous emergence from the marine limit throughout the peripheral depression. Relative sea level curves from the full glacial sea confirm previous morphostratigraphic and glacioisostatic evidence for limited ice extent during the last glaciation. These curves also document the history of glacial unloading and the form of the relative sea level curve that one would theoretically expect in the peripheral depression. The form of the curves presented here is unlike any other published emergence curves from Arctic Canada or from Fennoscandia.

The relative sea level curves for northeast Ellesmere Island show three segments: (1) an interval of stable relative sea level (isostatic equilibrium) at the marine limit between at least 11 000 and 8000 BP; (2) an interval of slow emergence from 8000 to 6200 BP during which northeast Ellesmere Island ice slowly retreated; and (3) an interval of rapid emergence, caused by rapid glacial unloading, after 6200 BP when a prominent amelioration was in progress. These curves are of regional importance in that they provide a new means of distinguishing between areas that were ice covered and ice free during the last glaciation.

During the summer of 1982 field work was extended across northern Nares Strait to Hall Land, northwest Greenland. The principal objective was to clarify the pattern of postglacial emergence across the Nares Strait rift valley and particularly to test the proposed glacio-isostatic dominance of the Greenland Ice Sheet on the emergence of northeast Ellesmere Island. Prominent moraines marking the last glacial limit extend 40 to 60 km down Petermann Fiord and Newman Bay from present day glaciers. These moraines flank the extremities of a large lowland that extends from Petermann Fiord to Newman Bay through the interior of Hall Land. The moraines were deposited below sea level when the full glacial sea inundated the entire interior of Hall Land (between the fiord glaciers). The marine limit in the full glacial sea is isostatically tilted from ca. 120 m a.s.l., along the adjacent coast of Ellesmere Island, to ca 140 to 150 m a.s.l. along the distal side of the Petermann Fiord moraine.

Radiometric dates on collected samples are not yet available but based on the onset of rapid emergence on northeast Ellesmere Island (ca. 6200 BP) ice retreat from the Hall Land moraines should be of similar age. Marine limits of the full glacial sea in the interior of Hall Land should be >8000 BP. An interval of slow initial emergence is suggested by the difference of ca. 25m in the elevation of the marine limits on the immediate distal and proximal sides of the moraines. Collectively, the Quaternary stratigraphy and sea level record on Hall Land confirms the Ellesmere Island model which indicates limited ice extent and the existence of a full glacial sea in northern Nares Strait during the last glaciation.

James Fitzjames Captain HMS Erebus

F.R.M. Crozier Captain & Senior Offr

and start on tomorrow 26th for Backs Fish River

deaths in the Expedition has been to this date 9 officers & 15 men.

H. M. S.hips Erebus and Terror

Wintered in the Ice in

28 of May 1847 Lat. 70°5' N Long. 98°23' W

~~Having wintered in 1846—7 at Beechey Island~~

~~in Lat 74°43'28" N. Long 91°39'15" W After having~~

~~ascended Wellington Channel to Lat 77° and returned~~

by the West side of Cornwallis Island.

~~______________________________ Commander.~~

Sir John Franklin commanding the Expedition

All well

Whoever finds this paper is requested to forward it to the Secretary of the Admiralty, London, *with a note of the time and place at which it was found:* or, if more convenient, to deliver it for that purpose to the British Consul at the nearest Port.

Quinconque trouvera ce papier est prié d'y marquer le tems et lieu ou il l'aura trouvé, et de le faire parvenir au plutot au Secretaire de l'Amirauté Britannique à Londres.

Cualquiera que hallare este Papel, se le suplica de enviarlo al Secretario del Almirantazgo, en Londrés, con una nota del tiempo y del lugar en donde se halló.

Een ieder die dit Papier mogt vinden, wordt hiermede verzogt, om het zelve, ten spoedigste, te willen zenden aan den Heer Minister van de Marine der Nederlanden in 's Gravenhage, of wel aan den Secretaris der Britsche Admiraliteit, te London, en daar by te voegen eene Nota, inhoudende de tyd en de plaats alwaar dit Papier is gevonden geworden.

Finderen af dette Papiir ombedes, naar Leilighed gives, at sende samme til Admiralitets Secretairen i London, eller nærmeste Embedsmand i Danmark, Norge, eller Sverrig. Tiden og Stœdit hvor dette er fundet önskes venskabeligt paategnet.

Wer diesen Zettel findet, wird hier-durch ersucht denselben an den Secretair des Admiralitets in London einzusenden, mit gefälliger angabe an welchen ort und zu welcher zeit er gefundet worden ist.

Party consisting of 2 Officers and 6 Men left the Ships on Monday 24th May 1847

G.M. Gore Lieut.

Chas F. Des Voeux Mate.

25 April 1848 HM Ships Terror and Erebus were deserted on the 22nd April. 5 leagues NNW of this having been beset since 12th Sept 1846. The officers & crews consisting of 105 souls under the command of Captain F.R.M. Crozier landed here in Lat 69°37'42" Long 98°41' This paper was found by Lt. Irving under the cairn supposed to have been built by Sir James Ross in 1831 4 miles to the Northward where it had been deposited by the late Commander Gore in June 1847. Sir James Ross' pillar has not however been found and the paper has been transferred to this position which is that in which Sir J. Ross' pillar was erected — Sir John Franklin died on the 11th June 1847 and the total

Rising Sea Level and Glacier Surge

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If the chronological system adopted by Hillaire-Marcel and Fairbridge (1) for the Hudson Bay beach ridges is reasonably correct, supported as it is by more than a dozen radiocarbon rates and its own uniformity, evidence of rapid sea-level fluctuations in the mid-Holocene demands explanation. Storm-generated seiche effects and wave set-up can explain the 45-yr beach-building cycles that have a local climatic correlation, but secular trends continuing for centuries suggests at least some eustatic, i.e. global, component.

Two negative fluctuations, corresponding to beach #75 (3349) and #111 (4983BP) are shown to have been abruptly followed by extremely rapid sea-level rises, respectively by 3.827m (at 17.2mm.yr^{-1}), and 2.581m (14.5mm.yr^{-1}). If we assume for the moment that these are eustatic, then each rise in the surface of the world ocean would require a catastrophic rise in the melt-rate of polar ice, to a rate at least one order of magnitude greater than anything recorded during the last three centuries. A 3m eustatic rise would involve 1.08 x $10^6 km^3$ of meltwater.

If we accept the Wilson glacial surge model, the Antarctic ice shelves would tend to become mobilized during an interglacial warm stage (and eustatic high), as the glacier ice became warmer and less rigid. The evidence presented here suggests a slightly modified model. A short-term but abrupt <u>cooling</u> trend and eustatic fall ($>$3m) of about 2 centuries is indicated by our data that would trigger the surge. This will shift the locus of ice-shelf grounding seawards and increase the gradient. Ice-surge modelling experiments by Budd and McInnes (2) postulated a surge lasting 250yr, which is in the right order of magnitude. A runaway surge would carry the floating ice far out into the Southern Ocean, where the raised albedo of ice surfaces and the injection of cold, low density water into the major southern gyres, notably to Peru ("Humboldt") Current, would catastrophically lower global air temperatures. Palynological evidence suggests world-wide cooling, with brief but extreme desiccation in the subtropics (Fairbridge, 1976). The melting ice would, however, raise sea level, this rise being initially out-of-phase with the cooling air temperatures. The extreme cooling episodes ("spikes") were evidently very brief, occupying only a few decades or perhaps centuries. The relative heights of Hudson Bay beaches #111 and #75 suggest an abrupt fall of ocean level of $\sim$3m from the preceeding one during a single 45yr cycle. The wide distribution of meltwater would dramatically raise the evaporation rate from the oceans, cooling further the air temperatures and thus favor the expansion of polar ice caps as well as mid-latitude mountain glaciers (Patagonia, New Zealand, Alaska, Scandinavia). A repetitive surge-eustatic-climatic model could be considered in the light of both the Hudson Bay and global temperature fluctuations.

Both the beach levels cited (#75 and 111) have dates within the confidence error limits that coincide with a major solar/terrestrial orbital cycle (the 1668-yr "Zero-check" of Stacey, 3), of 3297 and 4965BP. An exogenetic triggering of the Holocene cycles is worth considering (Fairbridge, 4). The last planetary "stellium" was in AD 1962, but in fact nothing happened. The same may not be true, however, if the postulated CO_2-generated global warming eventuates. The world sea-level is now rising at $\sim$2mm.yr^{-1}.

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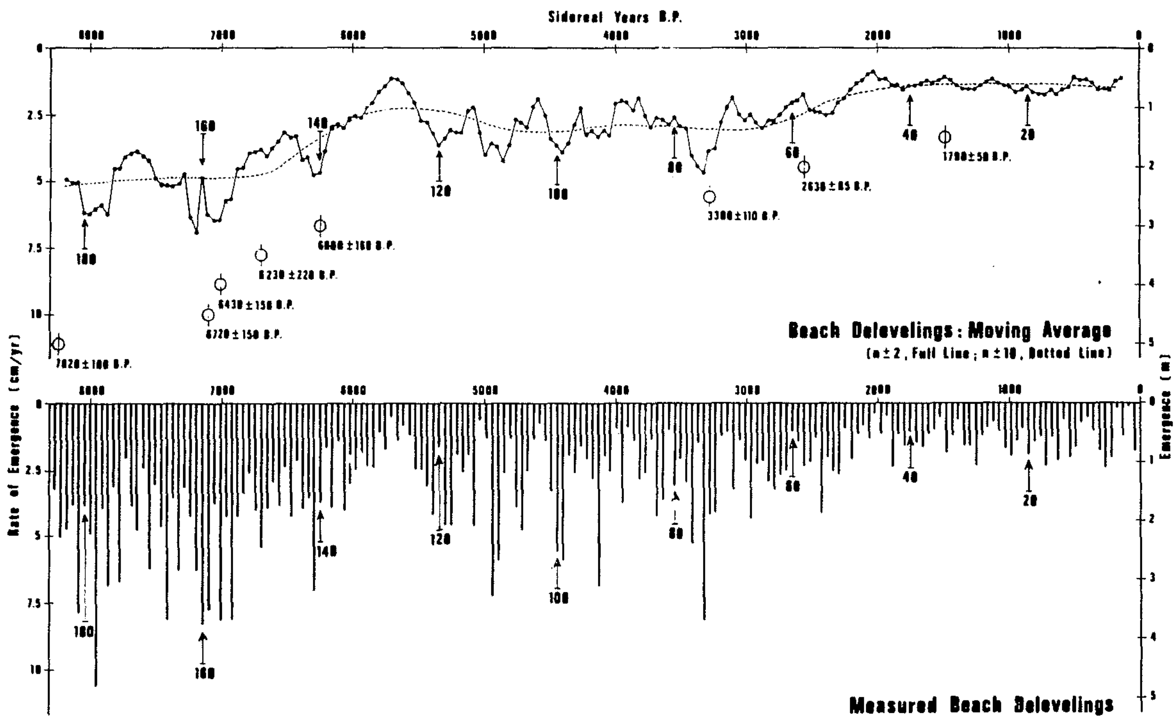

Fig. 1. Synthesis of Hudson Bay raised beach sequences, with glacìostatic factor removed, expressed as rates of emergence (in cm/yr). Upper curve: moving averages, with points controlled by radiocarbon dating. Time is expressed in sidereal years, assuming an approximately 45 yr cyclicity. Lower curve: individual beach measurements, numbered from 1 (1975) to 185 (approx. 8300 yr. B.P.).

Patterns of Post-fire Vegetation Development in Southern Labrador

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In southern Labrador black spruce-dominated lichen woodlands and paper birch forests are predominantly restricted to areas that have burned within the preceding 110 years. The two communities occupy contrasting sites and differ markedly in vegetation development, species composition, age-structure, composition and prominence of the various strata of vegetation, and relative importance of the different plant growth forms in community organization and structure. The development of the lichen woodland and birch forests creates a mosaic that augments the compositional and structural diversity of the regional vegetation. The juxtaposition of the successional and mature vegetation types also serves to increase the spectrum of habitats available to the boreal fauna of this region.

The lichen woodlands develop following fire in the Black Spruce-*Pleurozium* forest, which is a ubiquitous vegetation type occupying a wide range of sites from poorly drained outwash plains to sandy river terraces and hill crests. The pattern of vegetation development in lichen woodlands is heterogeneous, as the different strata of vegetation respond differently to disturbance and utilize contrasting strategies of regeneration. Arboreal regeneration is slow as a result of the limited availability of seedbeds; the progressive establishment of trees results in an uneven age-structure of stands and a long period when open woodlands dominate the landscape.

The majority of the species in the vascular understory follows the pattern of initial floristics and resprout rapidly following fire. The well-developed cryptogam layer undergoes physiognomic changes that represent the individualistic behavior of species with different growth and dispersal rates, contrasting substrate requirements, and varied response to a temporally changing environment. Analysis of the organic soil layer in old-age forests reveals a stratigraphy that parallels the succession in the ground cover observed in extant stands of progressively older age: mineral soil -- charcoal -- *Polytrichum juniperinum* -- *Cladonia* lichens -- *Pleurozium schreberi* -- Feather Mosses -- *Sphagnum girgensohnii*.

In contrast to the lichen woodland the strict site preference of paper birch restricts the birch community to concave hillslopes with well-drained soils, which are well-aerated, nutrient-rich, and constantly moist. The development of a mull humus undoubtedly contributes to the favorable soil conditions. These stands are distinguished by a lush and floristically rich vascular understory.

The stratigraphic record in organic soil profiles shows that birch stands develop following fire in conifer-dominated forests. A basal mor humus layer contains bryophyte and conifer macrofossils and abundant conifer pollen; it is separated by a charcoal horizon from an upper profile of mull humus in which the pollen of birch, alder, and *Lycopodium* is abundant and bryophytes are generally absent.

Age-structure analysis shows that rapid seedling establishment by birch following fire results in the formation of an even-aged and closed overstory. The understory resprouts and increases dramatically from the residual levels in the burned conifer forests to form a lush and continuous layer in birch forests. Cryptogams are insignificant in the birch forest.

Recent Spring Warming in North America along the Snowline

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Differences between mean monthly surface air temperatures over the U.S. and Canada in the 1951-80 and 1931-60 intervals were examined. The analysis was based on state climatic divisions in the U.S. and close to 200 station records in Canada.

In the U.S. during the more recent interval cooler temperatures prevail over the eastern half of the country from December through February and from May through October. In the west, April is cooler while positive anomalies are found during January and especially February. In contrast to the rest of the year, November and March show strikingly little change although slightly warmer recent temperatures are noted in the north central section of the country.

The warm February anomaly extends north into western Canada. Recent warming is also observed in Canada from March through June and again in October and November. The warm anomalies in March, April and May are in the vicinity of the minimum monthly snowline as obtained from the 1974-80 weekly NOAA/NESS snow charts. From March through May the anomaly shifts northward with the retreating snowline. The October and November anomalies also appear to be related to the zone of unstable seasonal snow cover.

The observed pattern indicates that the snow-albedo feedback may be active in this area. Although this could be related to increased CO_2, other explanations cannot be ruled out.

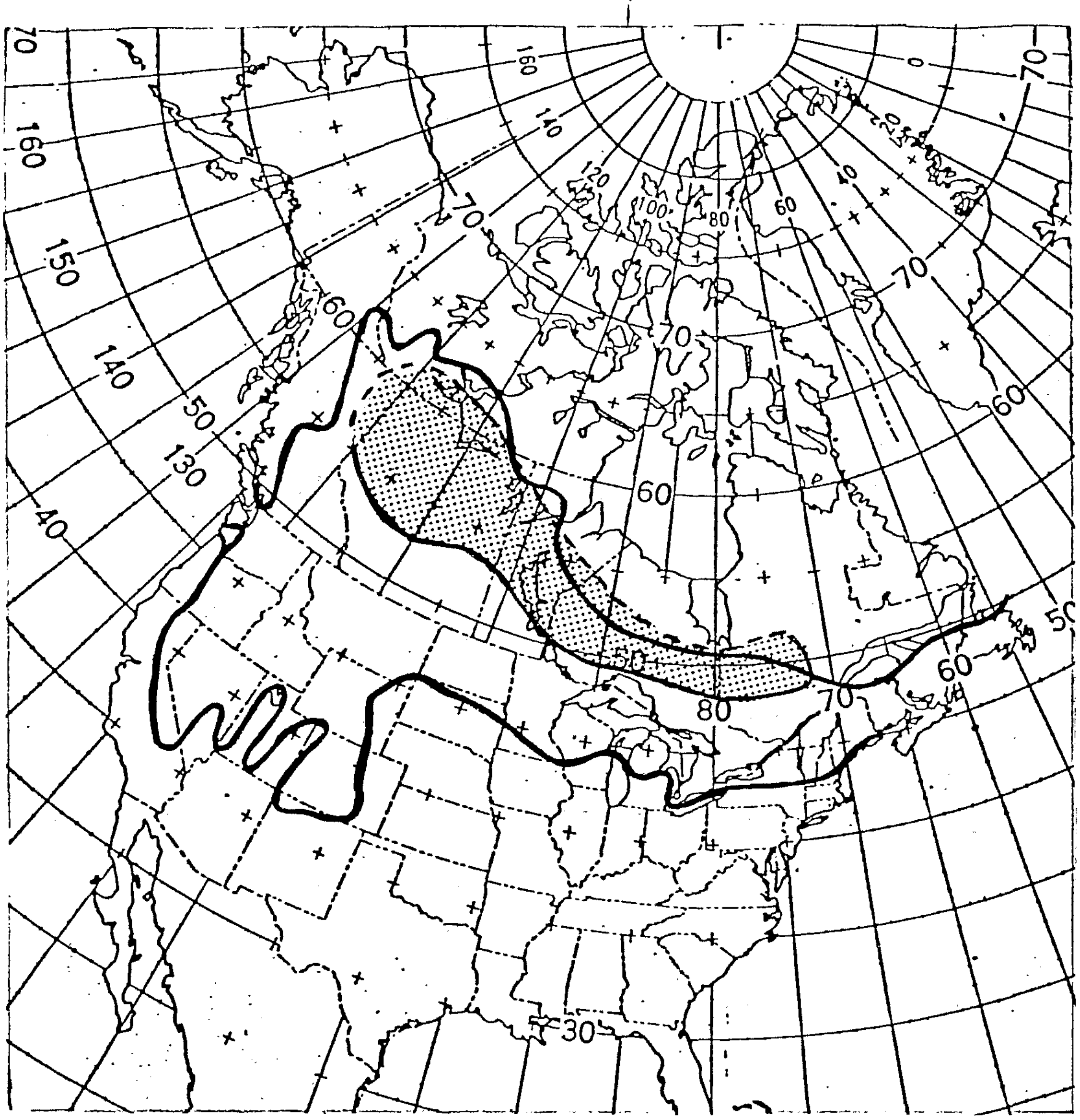
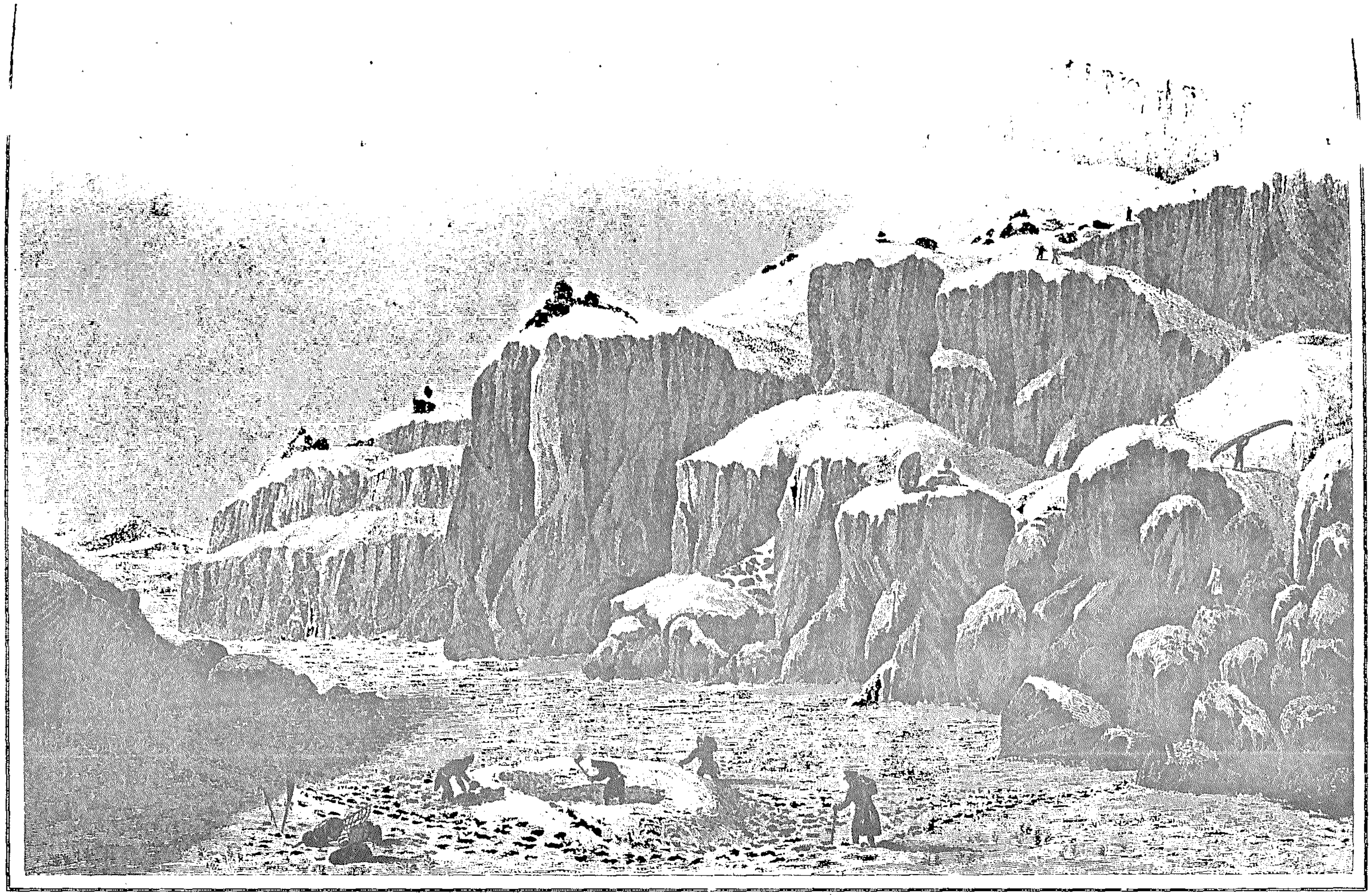


Figure Caption

Zone where the average April surface air temperature in the 1951-80 period was warmer by 0.7°F than during the 1931-60 interval. (stippled). Northern boundary approximate due to the limited number of stations. Heavy solid lines show the maximum and minimum snow cover extent in April during the 1974-80 period.

From Narrative of a Journey to the Shores of the Polar Sea in the Years 1819, 20, 21 and 22, J. Franklin, London, 1823.



Drawn by Lieut. Back, R.N. Engraved by Edwd. Finden

PREPARING AN ENCAMPMENT ON THE BARREN GROUNDS

Gathering Tripe de Roche & c. Sept., 16

Holocene Glacier Variations Across the Central Brooks Range, Alaska.

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A sequence of Holocene glacier advances has been established by lichenometry for 15 cirque glaciers north of the continental divide in the west-central Brooks Range. The Rhizocarpon geographicum growth curve developed for the Atigun Pass region of the east-central Brooks Range[2] has been used in the Killik River area to establish initial periods of end moraine stabilization at about 4400, 3400, 1800, 1100, 750, 320, and 70 yr BP. These dates represent major stillstands or the onset of ice retreat. Eleven glaciers south of the divide in the Arrigetch Peaks area show a similar morainal record of ice expansion, with the addition of a series of moraines dated at ~2900 yr BP[1]. For half of the west-central glaciers, the most well-defined ridges stabilized 475 to 325 yr BP (20-25 mm R. geographicum time). Moraine ridges of all ages are closely nested and older surfaces are often extremely discontinuous. Apparently successive advances resulted in similar amounts of net glacier extension. Moraines characterized by R. geographicum of less than 20 mm may in some areas represent pauses in the last ice retreat

Ubiquitous lichen-free and recently colonized zones at glacier snouts indicate that ice fronts have been retreating during the last century. Dead mosses emerging from a glacier snout in the upper Kurupa River region were radiocarbon dated at 300±100 yr BP, indicating that the glacier is smaller today than at any time in the last 300 years. Along with stone nets emerging at the same site, this suggests non-erosive, cold-based conditions for the preceding advances.

Moraines of the west-central and east-central Brooks Range are predominately ice-cored, with ice as near as 20 to 80 cm beneath platy rock debris. Some of these are up to 4500 years old, thus indicating that glacier cores are long lasting. Many moraine snouts are up to 60 m high and lie at the angle of repose. Such moraines with substantial glacier cores may flow as rock glaciers.

Glaciers of the west-central Brooks Range have a mean orientation of 005° and are strongly asymetric; over 90 percent of occupied cirques are oriented within 55° of the mean. This orientation minimizes direct radiation, allowing glaciers to exist in a marginal environment. The lowest glaciers of this area occur at 1250 m: this is 250 m lower than those of the Atigun region 200 km to the east. In addition, mean ice elevations rise to the north across the divide at 2.5 m/km, a trend similar in direction but at only 1/6 the gradient measured in the east-central Brooks Range. The result is a trend surface which rises and steepens to the northeast, away from the major precipitation source of the Pacific Ocean.

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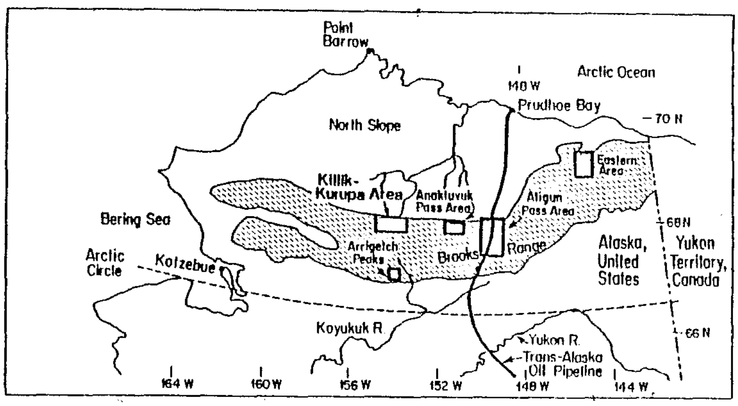

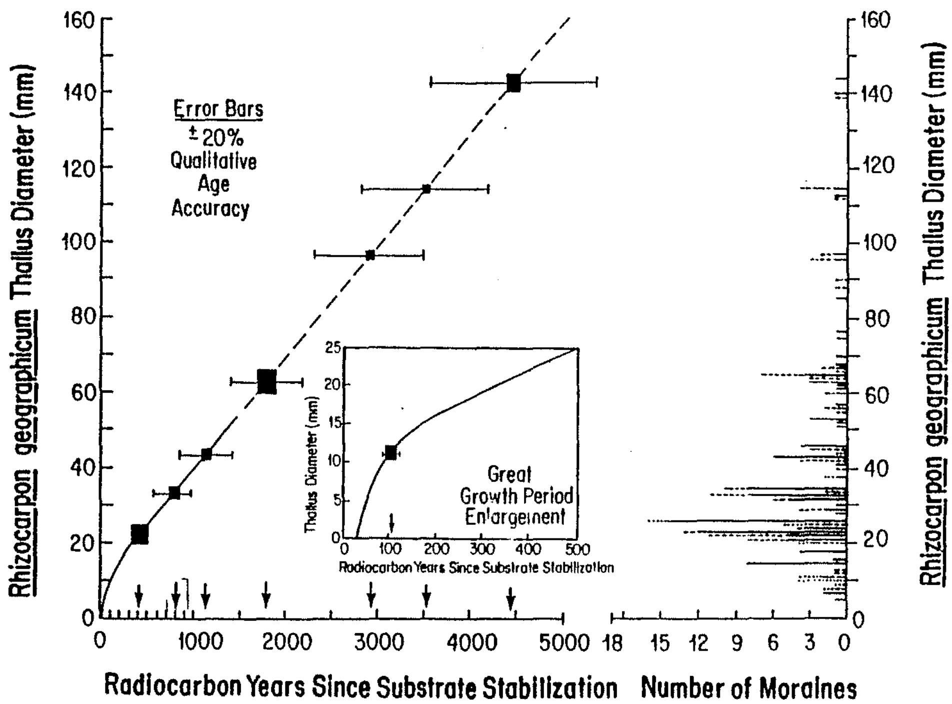

Frequency histogram of thallus diameters (right) representing cirque glacier deposits of the Atigun and Anaktuvuk areas (solid lines), Killik and Arrigetch areas (dashed) and the northeastern area (dotted). This is correlated with the R. geographicum growth curve (left) developed for the central Brooks Range. (Adapted from Calkin and Ellis, 1982.)

Fire Regime: A 2000-Year Record of Tundra Fire Occurrence for the Tulugak Lake Area of the Noatak Biosphere Reserve, Alaska

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The history and effect of wildfire on arctic vegetation is poorly understood. Lightning storms are the main cause of wildfire and a single storm may ignite several fires (1). The purpose of this study is to determine fire frequency and its effect on the vegetation of a small (approximately 4 ha) study site within the Noatak River watershed in northwest Alaska.

A 54-cm sediment core was recovered from a small pond (Pond J) northwest of Tulugak Lake (68° N. lat., 161° W. long.). A combination of low shrub-tussock tundra, white spruce taiga and small patches of cottonwood and green alder surrounds Pond J. Most of the area burned in a 1977 fire. Stands of burned and unburned alder, spruce and cottonwood line the banks of Pond J.

Time control is provided by a C^{14} date of 1750 ± 60 years before present(YBP) at 48-54 cm (Beta-4210). A sampling interval of .5 cm (representing a 15 to 20 year period) provides sufficient resolution to define past fire frequency. Preliminary results from microscopic analysis of charcoal fragments suggest the occurrence of 5-9 fires within the watershed of Pond J during the past 1900 years. A calculated return interval of 200-400 years agrees with values estimated from recent fire reports for the entire Noatak River watershed (2).

The 1900-year period represented by the core spans three climatic phases defined for artic regions (3,4). As many as 5 fires occurred during a relatively warm interval from approximately 1900-900 YBP. From 1-3 fires occurred between 900-300 YBP, a period believed to be cooler and drier than today. This past century represents a return to warmer, milder weather. The most recent fire burned 30,000 acres (121 km^2) during July 1977. These results suggest that wildfire is a natural part of this system.

Pollen analysis supports the fire regime outlined above. Large short-term fluctuations in CYPERACEAE percentages are associated with charcoal peaks. Cottongrass is an important component of the shrub-tussock community and is stimulated to flower by fire (5,6). A decrease in CYPERACEAE pollen percentages (from 38% at 40 cm to 11% at the surface) may reflect a long term decrease in the importance, occurrence and/or intensity of fire at Pond J. Increases in *Alnus* percentages may also indicate a decrease in the importance of fire. Alder stems are easily killed by ground fire and modern studies (7) indicate that tundra fire may limit the distribution of alder on the landscape. Pollen percentages of several other species fluctuate throughout the core and appear to be influenced by individual fires.

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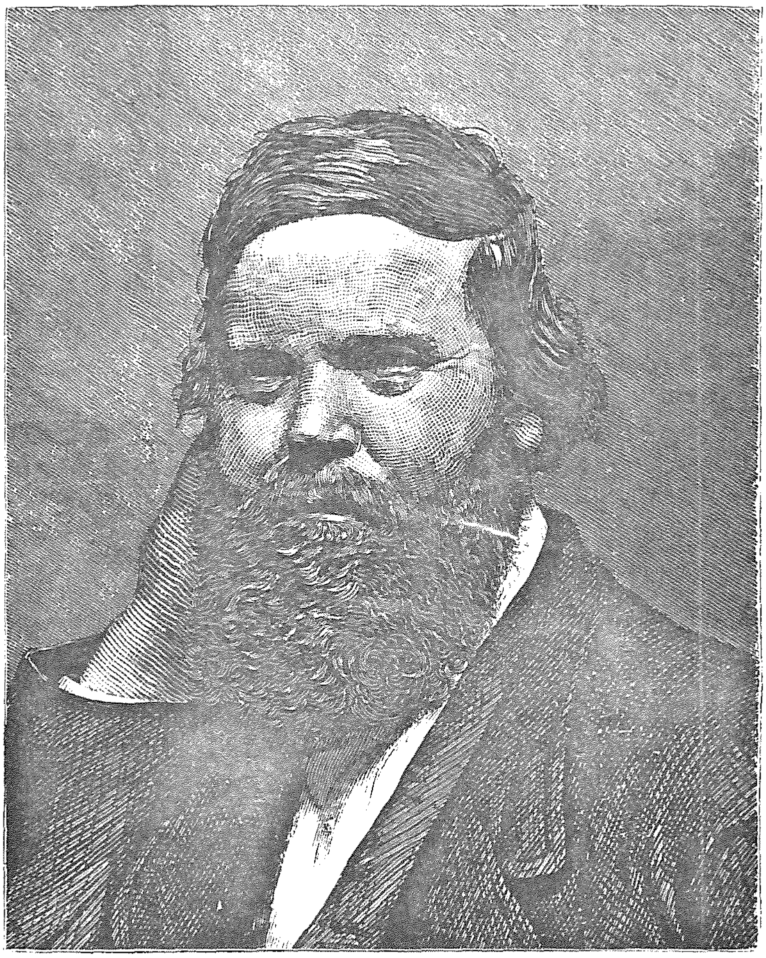

CHARLES FRANCIS HALL.

Paleoenvironmental reconstruction by fossil bryophytes in autochthonous, Holocene peats.

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Ten peat cores, reaching down to the mineral sediment, taken along a transect 7-km long in the center of the vast Red Lake Peatland in northern Minnesota, were analyzed to reconstruct the development of a mire complex consisting of forested ovoid bog islands separated by internal water tracks marked by patterned fens. The reconstruction of past bog, poor-fen, and rich-fen communities is based primarily on the quantitative analysis of fossil bryophyte assemblages (Janssens 1983). A new method of analyzing the changes in amounts of bryophytes was developed. Bryophyte concentration changes (expressed in number of fragments per volume of peat), accumulation rates (in fragments per area per time) and percentages of types are calculated and presented in stratigraphical diagrams (see Figure for illustration). The quantification became possible by developing a formula to calculate *Sphagnum* concentrations based on counts of *Sphagnum* plants, stems, branches and leaves, and by study of *Sphagnum* structure of living populations. This estimation of *Sphagnum* concentration made it possible to present *Sphagnum* together with other bryophytes in the same diagrams.

The sharply defined bryophyte zones were stratigraphically correlated among cores by radiocarbon dates, the regional pollen zonation, and buried wood layers. Peat-accumulation rates, calculated from radiocarbon dates, were correlated with measurements of bulk density, humification, and peat ontogeny as based on the local paleoenvironmental reconstruction. The peat stratigraphy indicates that bog vegetation originated about 5000 years ago at the watershed crest and then extended downslope, growing over rich-fen peat in the process. Cores from the internal water tracks contain a striking sequence in fossil assemblages, changing from a basal rich-fen zone to a bog or oligotrophic poor-fen zone and then reverting back to a rich-fen zone towards the top. This stratigraphy supports an earlier hypothesis, based on the study of present-day landforms, that the internal water tracks originated recently within a continuous complex of forested raised bogs, with poor-fen lawn flanks. Conversion of the bog into ovoid islands resulted in the complex landscape.

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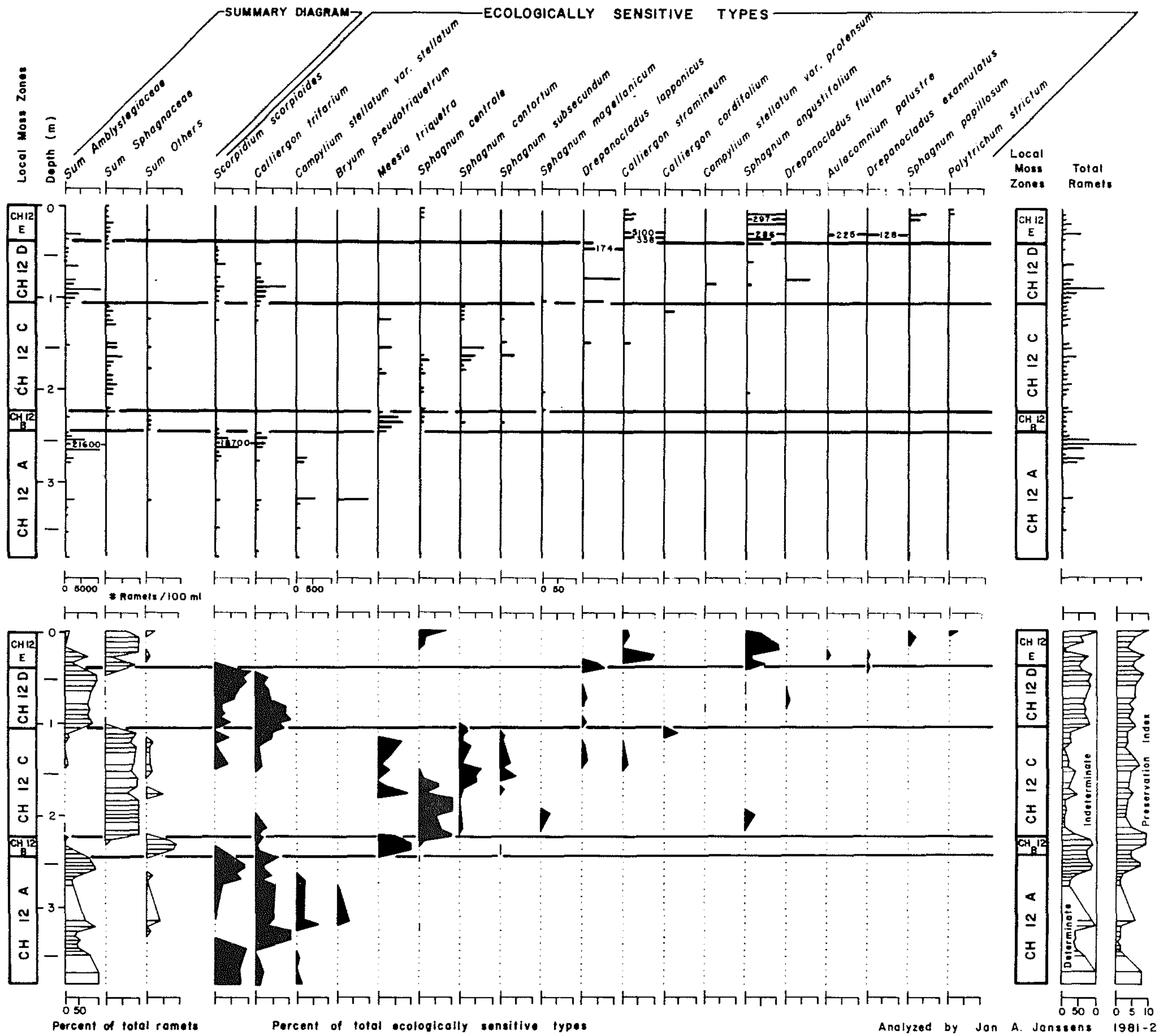
CHASEBROOK 12, Beltrami County, Minnesota



Cryospheric Impact of Large-Scale Water Transfers in the USSR

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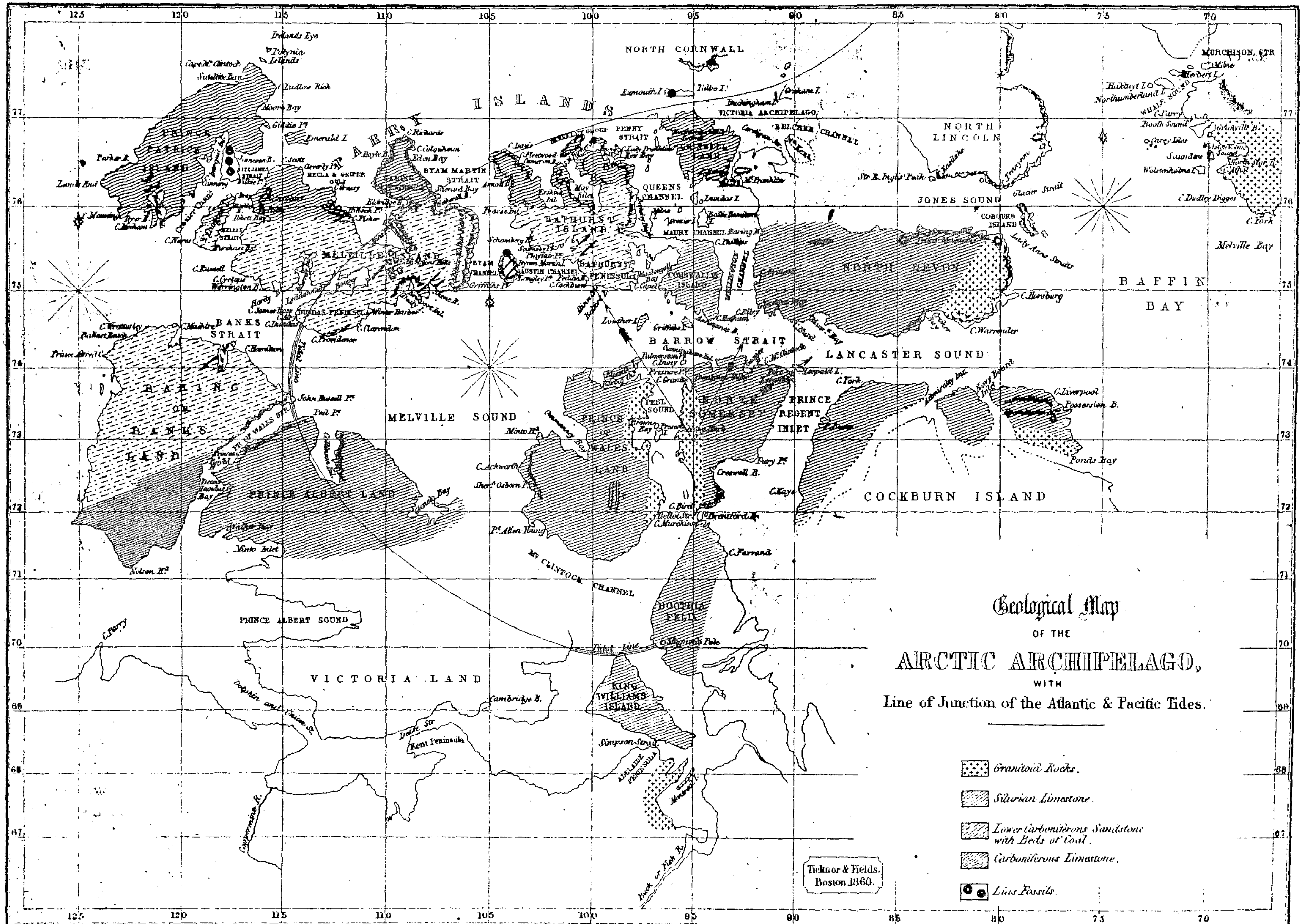
To meet the pressing need for increased water supplies in central Asia, the Soviet Union has decided to divert substantial quantities of water south. This water will be extracted from the Arctic-flowing rivers, the Pechora and Ob, amongst others. Although current withdrawals from these rivers are minor, it is estimated that by the year 1990 around $20km^3/yr$ will be extracted from the Pechora and other European rivers and that total transfers could reach $100km^3/yr$ early in the 21st century if the Ob and its tributaries are tapped. Transfers of up to $2\text{-}300km^3/yr$ have been proposed but are unlikely to be implemented until well into the next century.

This reduction in the freshwater discharge into the Arctic could have a significant impact on environmental conditions. The discharge of these rivers plays an important role in maintaining the characteristic ice cover of the Arctic Ocean and its marginal seas. It is not, however, at all clear how a change in riverflow will affect ice conditions. Some researchers claim that, as the freshwater discharge helps maintain the strong halocline in the surface layers suppressing heat transfer from the subsurface warm Atlantic water, a reduction in riverflow will result in less ice cover. Conversely, others argue that there is a direct dynamical link between the discharge of the rivers into the Kara Sea and the flux of Atlantic water into the Arctic. A reduction in riverflow could, therefore, be expected to reduce the upward heat flux (particularly in winter), reduce the amount of warm surface water available for melting sea ice in summer, and reduce the net export of ice both from the Kara Sea and the Arctic Ocean. This would lead to an increase in ice cover. In fact, precisely how much water can be diverted before any detectable effect occurs remains uncertain.

In this paper, we describe an empirical evaluation of the nature and magnitude of the cryospheric response to riverflow reductions. Flow data for the Pechora, Dvina, Ob and Yenisey are correlated with sea-ice concentration data for the Arctic Ocean and marginal seas. The strongest relationships are found between the flow of the Ob and Yenisey and local ice conditions. The major impact of riverflow diversions is likely to be on the formation of ice in the second half of the year. The dominant mechanism is considered to be the decrease in salinity stratification caused by riverflow reductions. There is, however, also a suggestion that ice decay the following spring may be influenced as the compensatory inflow of Atlantic water is affected in the Greenland and Barents Seas.

From A Narrative of the Discovery of the Fate of Sir John Franklin and His Companions, F.L. McClintock, Boston 1860

Map compiled by Rev. S. Haughton from specimens brought back by Capt. McClintock.



Geomorphology of a Glaciated Arctic Valley System, Brooks Range, Alaska.

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Alpine valley features were examined during the 1982 field season at the headwaters of the Kurupa River system along the northern flank of the central Brooks Range, Alaska. The valleys, last scoured by late Wisconsin-age ice, are distinctly U-shaped and headed by north facing cirques occupied by active glaciers above 1660 m. Resistant sandstone conglomerate members of the Kanayut Formation create indurate bedrock riegels and control the longitudinal morphology of the valleys. The riegels give these valleys their stepped profiles, they impound lakes and cirque glaciers, and they control stream patterns. Valley cross-sections show 50-100 m of fluvial downcutting into these resistant units. Outwash terraces of mid Holocene age or older occur less than one meter above present stream levels; this implies that major fluvial downcutting occurred prior to the mid Holocene.

Ten cirque glaciers and their Neoglacial deposits were examined at the valley heads. Deposits of ice cored morainal debris are evident in those cirques characterized by very high and steep walls. Deposits of glaciers in shallow cirques are very thin; they often lack ice cores with some debris little more than a boulder in thickness. This indicates that rockfall and avalanche debris provide the major component of morainal debris. Furthermore this demonstrates the effect of topographical screening on the preservation of ice cores. Several species of lichen were identified, measured and mapped in the field to determine relative age of the moraines. Provisional absolute age relationships were determined by using the lichen growth curve developed for the Brooks Range (Calkin and Ellis, 1980). Preliminary results of these lichen measurements on the Neoglacial moraines indicate that there were several periods of glacial advance which are consistant with chronologies established elsewhere in the Brooks Range (see Haworth et. al., this volume).

The most consipuous landform along the valley walls are fan deposits. A study of 42 of these fans show a continuum between a) small, steep (20°- 28°) colluvially-fed forms and b) larger, gentler sloping, (40°- 15°) finer-grained fans dominated by ephemeral stream deposits derived from large basins of low relief. Slush- or snow-transported debris deposited during spring melt supplies a distinct component on both fan types. Unique, leveled chutes occur on steep talus-derived fans and more subtle, broad, convex lobes form a component of the gentler alluvial fans. Dense lichen cover with <u>Rhizocarpon</u> <u>geographicum</u> thallis larger than 200 mm occurs on broad areas of several of these deposits. This suggests that they may have been more active during the early Holocene/late Pleistocene valley deglaciation.

Rock glaciers, both talus-supplied lobate forms on valley side walls, and tongue-shaped forms associated with glacier ice in cirques are common in the upper Kurupa valley system. Tongue shaped lobes are locally overrun by Neoglacial moraines and represent an older period of glacial activity. The more abundant lobate rock glaciers appear clearly active only above 1600 m but they occur as low as 1000 m in various stages of decay. These lower-lying forms are thinner (14-38 m), have gentler front slopes (15°- 35°) and a heavier lichen cover than the active forms, all indicating that activity since early Holocene time has been greatly reduced.

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Quaternary stratigraphy and ice limits; Forlandsund region, West Spitsbergen, Svalbard.

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A program of field research was undertaken in the Forlandsund region by Lehman and Forman in 1982 and by Miller in 1979. This work emphasized the mapping of raised marine features and limits of glaciation, stratigraphic analysis of wave-eroded sections, and the collection of molluscan assemblages from both sections and raised marine surfaces. These studies were followed by amino acid dating anlysis of in situ molluscs at the INSTAAR Lab. Aminozones reported in this abstract are modified from Miller (1982).

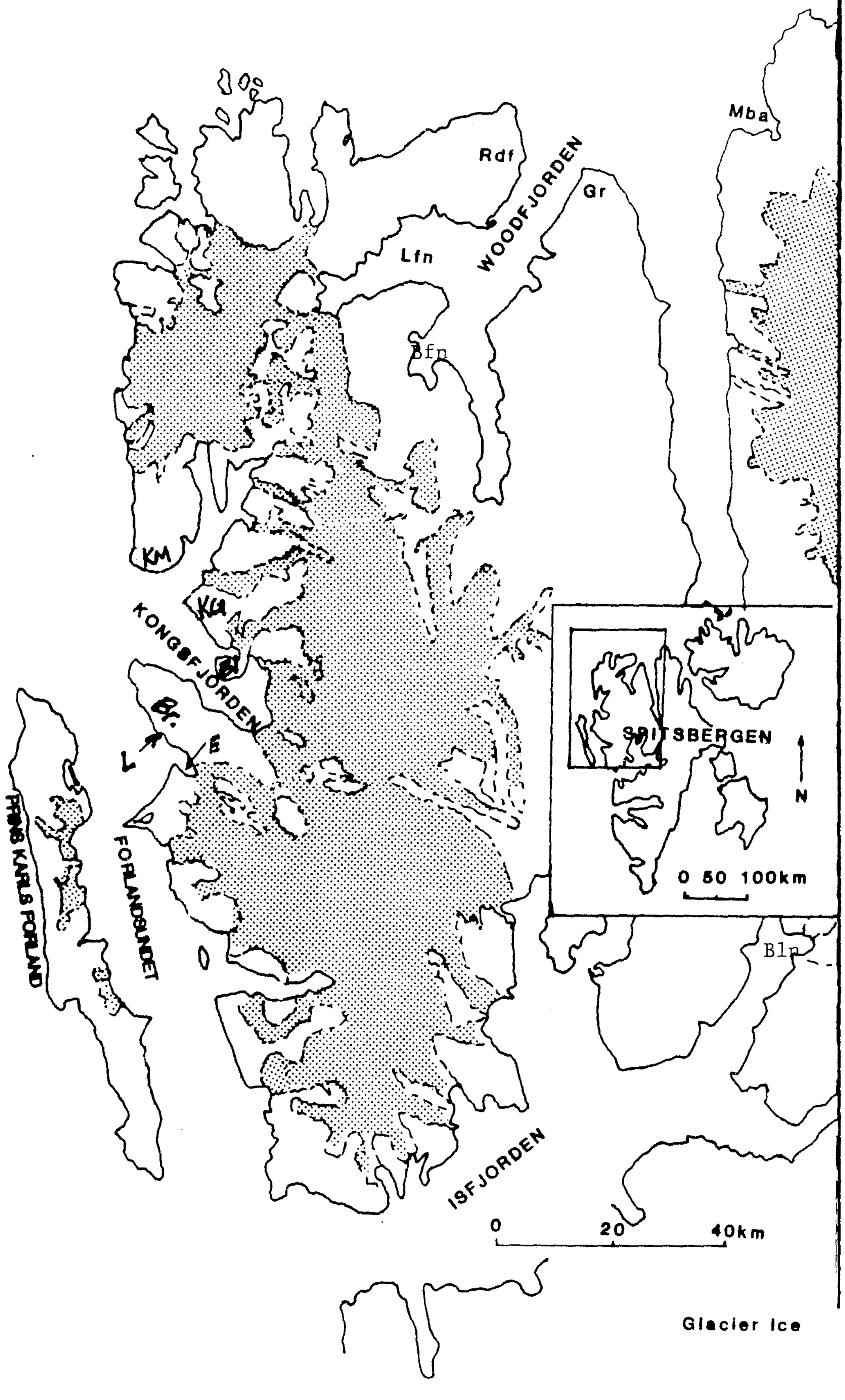
Wave-cut cliffs on the Forlandsund coast of Prins Karls Forland expose a series of three superposed emergence sequences (Aminozones A,B,C). These emergence sequences are not separated by glacial or glacial-marine diamictons as is usually the case for areas of glacio-isostatically controlled marine deposition.Across Forlandsund at Broggerhalvoya and at Kap Guissez wave-cut cliffs expose a more complex stratigraphic record where local and regional glacialmarine diamictons and tills separate emergence units. Soils are developed in the littoral caps of the emergence deposits indicating periods of prolonged subaerial exposure between glacial and glacial-marine events. Emergence sequences on either side of Forlandsund can be chrono-correlated by aminostratigraphy and require that ice draining from the main island has not crossed Forlandsundet since sometime prior to Aminozone C time.

Aminozone A, B and possibly C beaches remain preserved on Prins Karls Forland, Broggerhalvoya, Kap Guissez and on Kap Mitra requiring that these areas have not been inundated by regional ice since sometime prior to Aminozone B or C time. A glacial trimline terminating just beyond Blomstrandhalvoya records the maximum extent of Billefjorden stade ice (9 - 11 ka BP, Boulton 1979a, our Aminozone A) in Kongsfjorden. During Aminozone B and C time ice occupied Engelsbukta but only advanced as far as Leinstranda, Brogger. On Prins Karls Forland Little Ice Age moraines represent the maximum extent of ice over the island since sometime prior to Aminozone C time. Local cirque glaciers on Broggerhalvoya expanded and drained into the surrounding fjords in Aminozone B and C times but apparently did not coalesce.

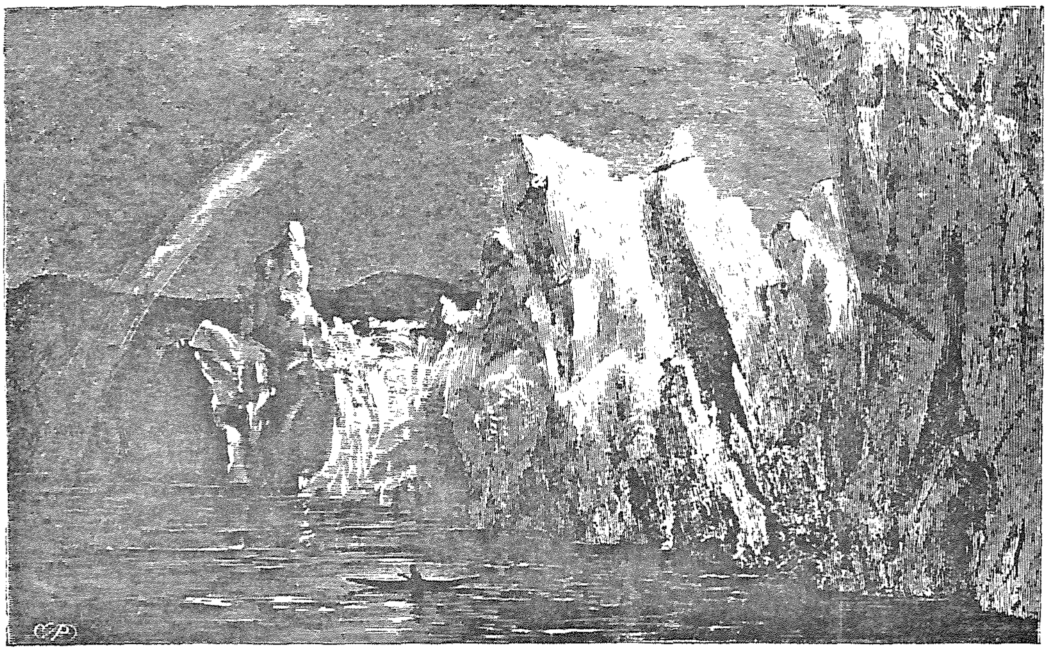
Thus centers of ice dispersal that depressed the Forlandsund region during Aminozone A, B, and C times have not actually innundated the area. These observations stand in contrast to assertions that the Svalbard archipelago was overwhelmed by ice in Weichselian times. Secondly, they pose constraints on the eastern margin of a possible Barents Shelf ice sheet.

Absolute age of Aminozones: By applying assumptions concerning the integrated thermal history experienced by sediment-enclosed molluscs, West Spitsbergen Aminozones can be bracketed in age. For younger materials the method can be calibrated against radiocarbon results. Aminozone A is 9 - 11 ka BP (radiocarbon control). The age of the Aminozone B episode lies within the range of 60 ka - 160 ka BP. This episode has been dated by radiocarbon on whalebone to > 61,500 yrs BP. Aminozone C is bracketed in age between 130 ka and 290 ka BP.

LOCALITIES MENTIONED IN THE TEXT



Bl= Blomstrandhalvøya
Br = Brøggerhalvøya
KM= Kap Mitra
KG= Kap GUISSEZ
E= Engelsbukta
L= LEINstranda



FRONT OF THE GLACIER.

THE GLACIER.

How shall I describe the scene which steadily opened to us as we steamed rapidly up the fiord.

Imagine it! The fiord is two miles wide; the valley beyond is of corresponding width, and the glacier fills it perfectly. How thick it is, of course, can not be told, but hundreds of feet it must be everywhere; it is probably from one to two thousand feet in many places. The banks of the fiord continued to be the banks of the glacier for about ten miles, gradually vanishing to a wedge-like point, and merging then into the great *mer de glace*, which, expanding to the right and left above the highest hills, carries the eye away upon its boundless surface as upon the ocean.

At length the inclined plane was lost; the distant line of the *mer de glace* was lost also, and we were beneath a line of ice-cliffs from one to two hundred feet high, as clear as the purest crystal, and emblazoned with all the hues of heaven.

A cold shudder crept over me as the vessel steamed in close to the front of this great reservoir of frost. The sound of falling waters filled the air, and ever and anon deep sounds, which seemed like convulsions of the earth, were emitted from it. The falling waters were of melted snow and ice from the surface of the glacier, which, gathering into streams of considerable size, leaped over the cliffs, and sent a cloud of spray floating away upon the air to resolve the sun's rays, giving back to the eye the fluttering

From The Land of Desolation, I.I. Hayes
(New York) 1872

The Ecology of Alder (Alnus viridis Furlow) at its Range Limit in Northwest Alaska

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Alder is the largest common shrub that occurs beyond tree line in northwest Alaska. Today alder reaches its northwestern range limit on the Seward Peninsula. Pollen studies suggest that is was absent from the area during much of the Wisconsin Glacial Stage and become abundant in the area only 7000-8000 years ago (1).

We have sampled alder stands in an effort to identify factors that explain its distribution. We are attempting to establish a modern framework upon which paleoecological studies of past distribution can be based.

We sampled nine representative alder stands measuring such characteristics as height, density, and age of alder stems, branching habit, extent of dieback, annual shoot elongation and substrate characteristics (associated vegetation, soils, slope and aspect and evidence of frost action). Stands were distributed on a rough N-S transect across the Seward Peninsula at elevations between 15 and 336 m. We found evidence for sexual reproduction at all of our sample sites. On alpine tundra or well-drained sites alder seems to require mineral soil for seedling establishment. On moist tundra seedlings can become established in Sphagnum, but they grow slowly. Vegetative propogation by layering and epicormic shoot formation is common at all sites. Individual alder stems varied in age from 2-114 years with several age classes evident in most stands.

Our results suggest that, except perhaps at high elevations, the present distribution of alder on the Seward Peninsula is limited primarily by the availibility of suitable substrates for seedling establishment and adequate soil drainage for survival and growth. Periodic tundra fires may limit alder distributions in some areas. Unlike most shrub species in northwest Alaska (especially Salix spp.) alder appears to reproduce vegetatively only from stem sprouts and not from root suckers following damage by fire. Stems we examined were easily killed by fire and most alder regeneration in burned areas appeared to occur as seedlings growing from seeds shed from cones that remained on old stems after they were killed by fire.

Analysis of alder pollen in surface sediment samples from the Seward Peninsula shows that alder percentages are typically 15-30 percent in areas where alder is common and 4-12 percent where it does not occur. These results suggest that past distributions of alder can be reconstructed using pollen analysis techniques. Variations may be explainable within the context of the results of our modern studies.

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Glacial Geology and Quaternary Marine Stratigraphy, Northeastern Ellesmere Island, N.W.T., Canada

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During the past decade, the extent of late Wisconsin/ Wurm ice over the High Arctic has been a highly controversial subject. Proponents of expansive ice favor the coalescence of the Laurentide, Innuitian and Greenland ice sheets to form a unified Arctic ice sheet (Blake, 1970; Hughes, Denton and Grossvald, 1977). Conversely, restricted ice over the Queen Elizabeth Islands, termed the Franklin Ice Complex, has been proposed by England (1976) for the last glacial maximum. During this time, England suggests the existence of an ice-free corridor between northeastern Ellesmere Island and Greenland along Nares Strait.

Morphologic and stratigraphic evidence from a 60 km section of coastline along Robeson Channel on Ellesmere Island supports the concept of a late Wisconsin/Wurm ice-free corridor. The following chronology is suggested: (1) Maximum advance of northwest Greenland ice onto Ellesmere Island, covering coastal summits and extending up to 20 km inland, (2) Retreating from this maximum stand, Greenland ice deposited moraines, ice contact stratified drift features were laid down and proglacial lakes were formed in two basins. An organic horizon excavated from a beach at 217 meters a.s.l. in one of the lake basins was dated at >36,000 B.P. To the north, in Wrangel Bay, a high marine shoreline at 285 meters was formed and related fossiliferous silt and diamicton was deposited (>32, 000 B.P.), (3) Holocene marine silts and beaches were deposited (7000 to 8600 B.P.). No evidence exists for overrunning or crosscutting of the older deposits by expanded late Wisconsin ice except in minor locations where local, thin plateau ice caps have expanded and spilled over into nearby lowland basins.

Analysis of lake cores recovered from basins in the coastal zone have two purposes: to help determine the character and duration of the ice marginal depression sea between Ellesmere Island and Greenland and secondly to aid in the reconstruction of the regional isostatic uplift history. Radiocarbon dates from the marine to lacustrine transition in the cores from three lakes at 12, 34 and 39 meters a.s.l. help to define the lower portion of emergence curves and hence the relative sea level history postdating initial emergence from the marginal depression sea.

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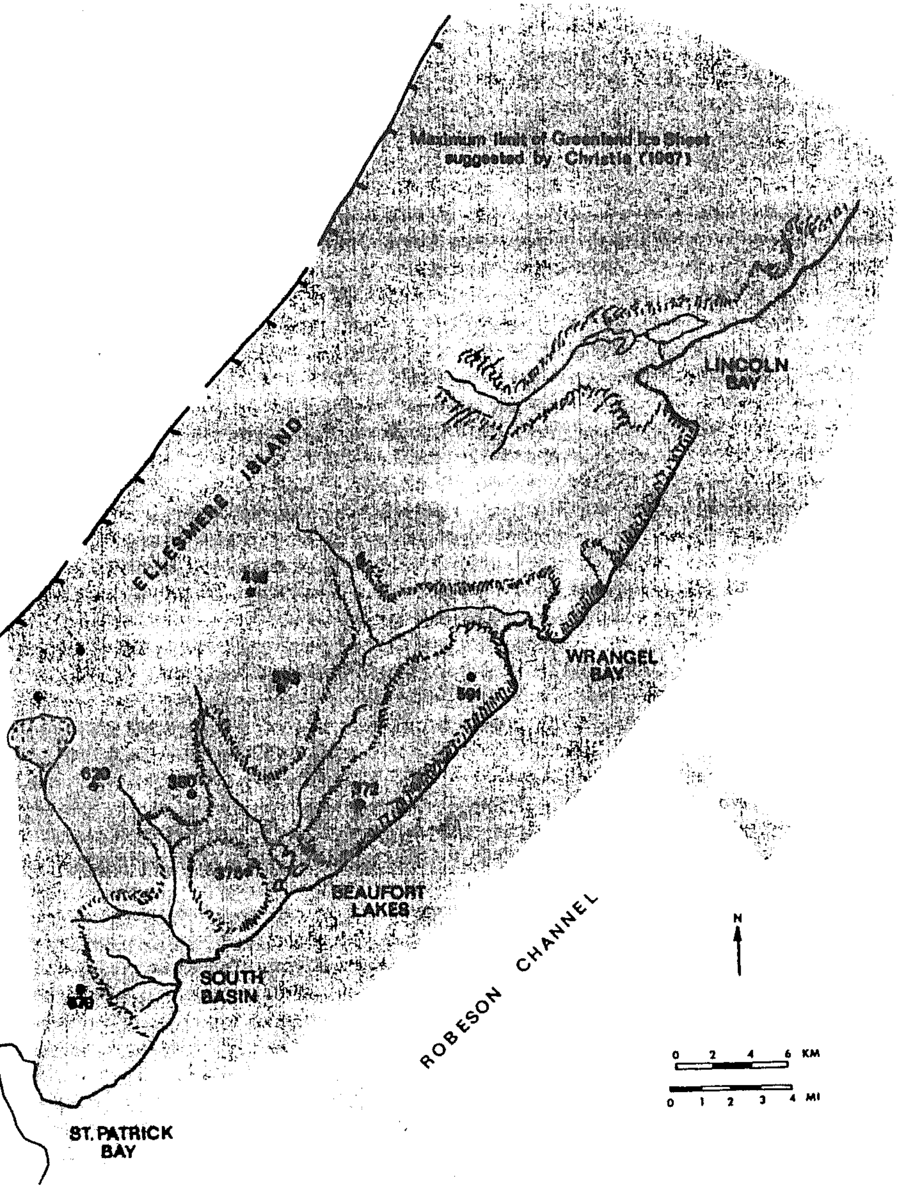


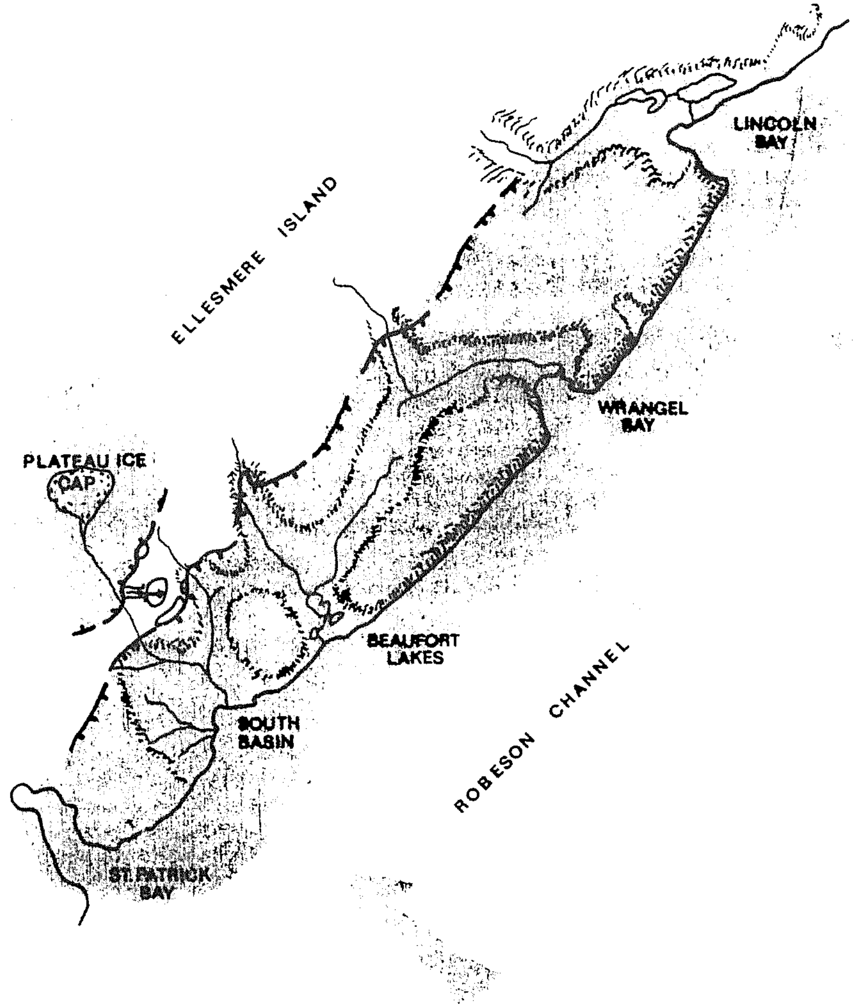


Figure 2. Retreat of Greenland Ice from maximum stand on Ellesmere Island.

Figure 1. Maximum advance of Greenland ice.

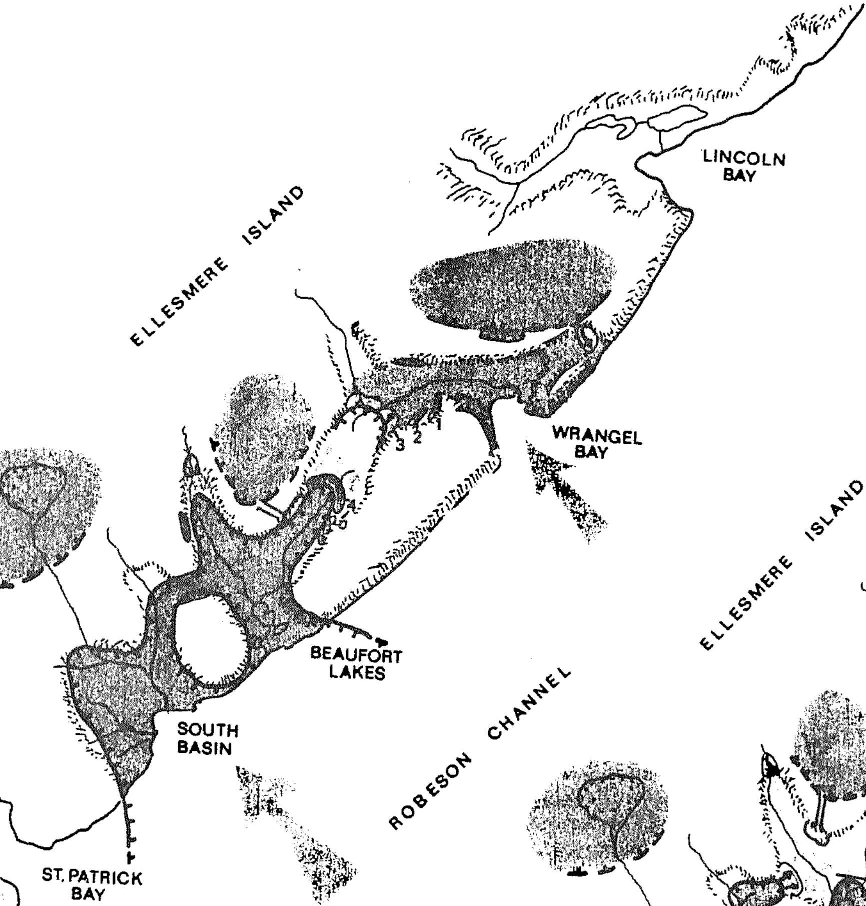


Fig. 3

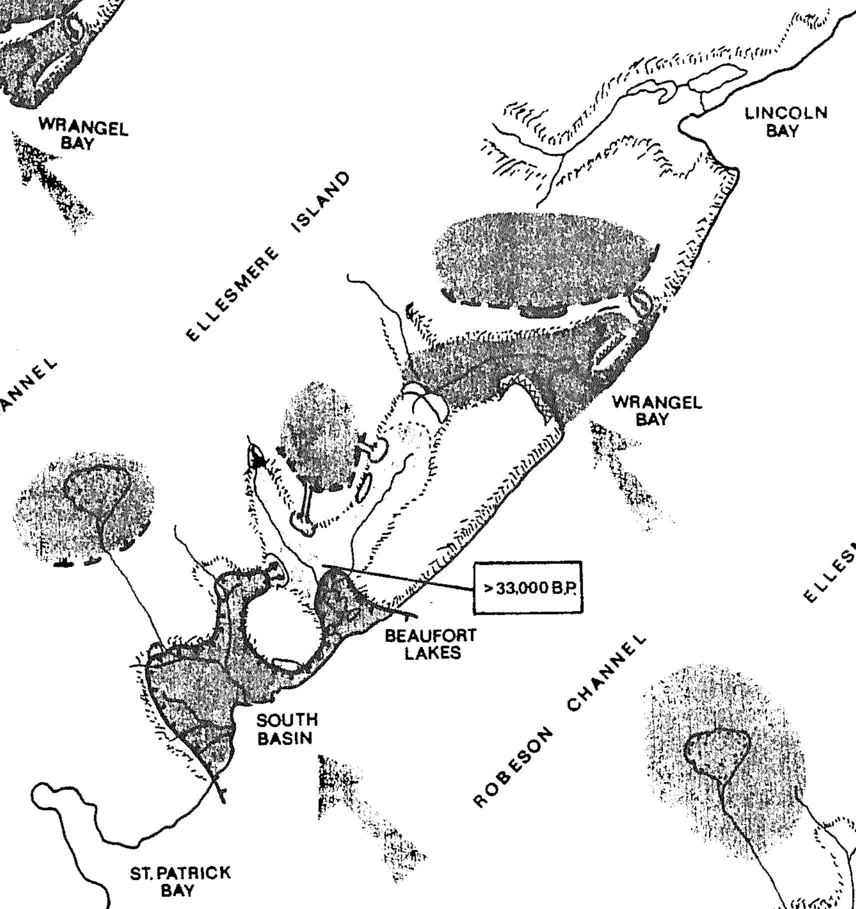
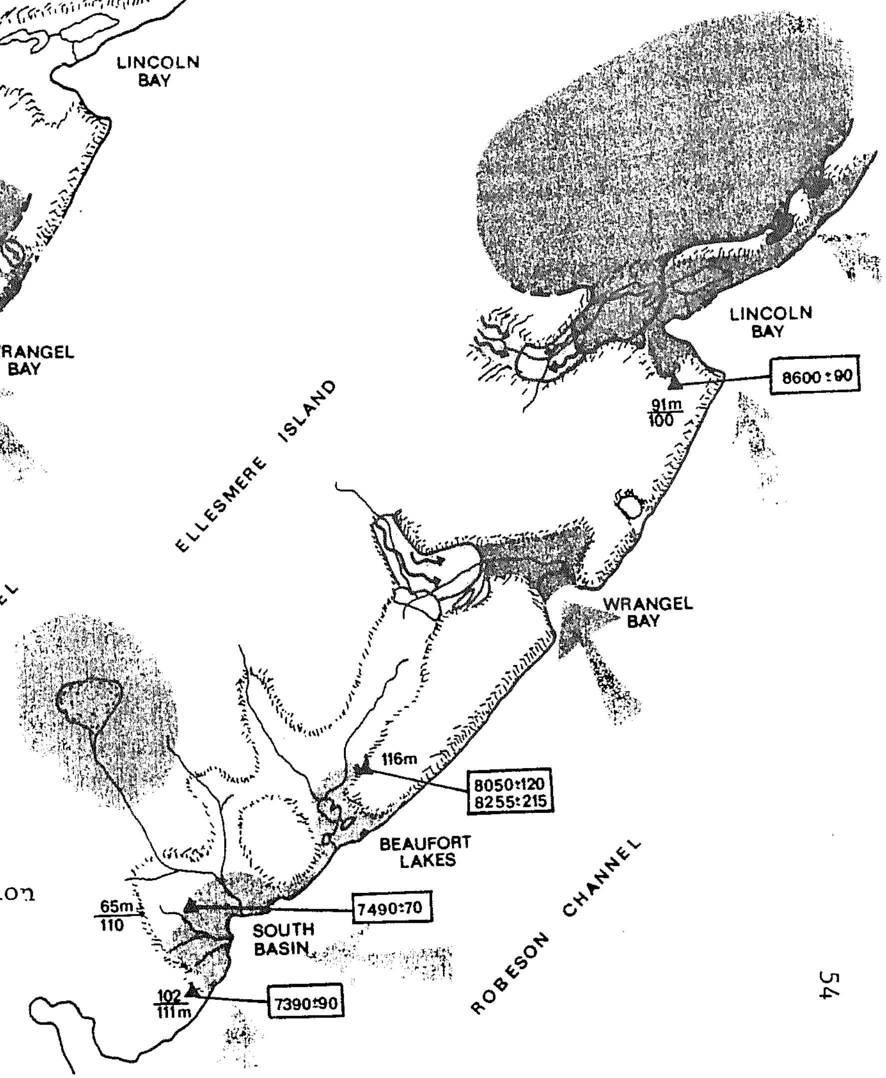


Fig. 4. Continued retreat with formation of proglacial lake, dammed by Greenland ice.

Figure 5. Holocene transgression



The Norwegian - Greenland Sea: A Critical Area For Global Oceanography and Climate

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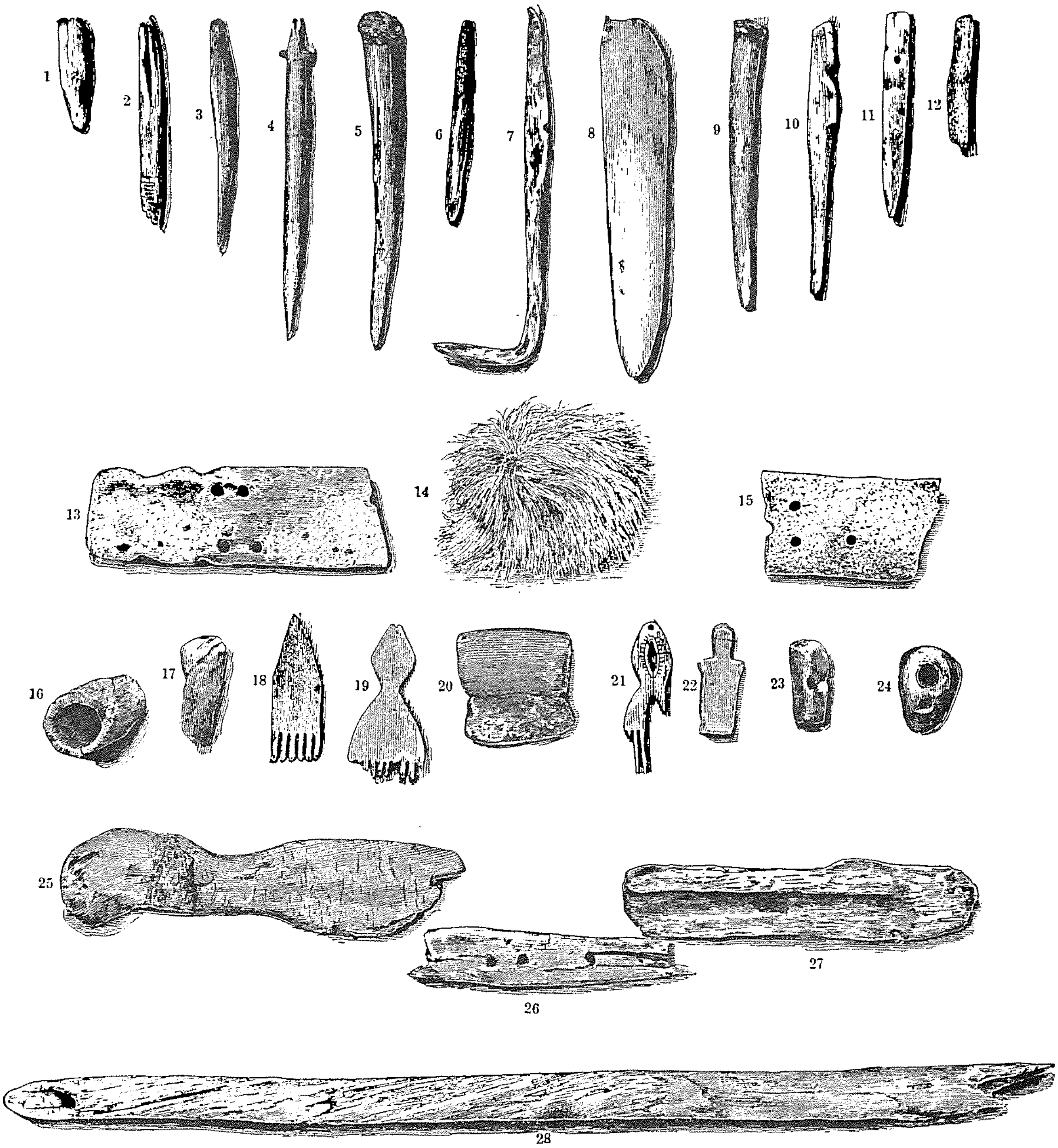
At present nearly all of the deep waters of the ocean are supplied in only two areas, the Norwegian-Greenland Sea in the north and the Weddell Sea in the south, with the Weddell Sea deriving its water from the Circumpolar Water which in itself is largely a product of North Atlantic Deep Water. Geological and climatic-oceanographic events in the Norwegian-Greenland Sea therefore can be expected to have large and global consequences.

The final linkage of the Norwegian-Greenland Sea to the North Atlanticduring the mid Miocene, about 15 m yrs ago, established the modern deep sea circulation pattern and was probably responsible for the buildup of the Antarctic Ice Sheet. Deep water foraminifers indicate that ever since the mid Miocene the North Atlantic deep water environment, in contrast to surface conditions there, fluctuated strongly with 20,00 yr and 40,000 yr periodicities, suggesting that the source areas for this deep water have been strongly influenced by climatic fluctuations caused by variations of the earth's orbital parameters.

The deep water fluctuations became amplified with the onset of northern hemisphere glaciations, about 2.5 m yrs ago and showed strong 100,000 yr periodicities for the past 700,000 yrs.

Faunal and geochemical evidence suggests that during northern hemisphere glaciations the Norwegian-Greenland Sea ceased to provide significant amounts of bottom water. The disruption of this supply of relatively saline and warm deep water to the circumantarctic region is probably responsible for the oceanographic and climatic change of the Southern Ocean: lowering temperatures, evaporation rates, salinities and biological productivity and thus permitting the expansion of southern sea ice during times of northern hemisphere glacial conditions. The deep water teleconnection therefore serves to synchronize northern and southern hemisphere climatic events.

Highly detailed deep sea records for the past 24,000 yrs reveal rhythmic fluctuations with periodicities of about 2500, 1500, 1000, and 650 yrs, leading to the suggestion that climatic oscillations of the 'Little Ice Age' type may be causedby oceanic teleconnections and feedback mechanisms that involve the Norwegian-Greenland Sea as the most sensitive triggering point.



Eskimo Relics Found at Junction of Lake Hazen and Ruggles River, June, 1882.

(From a photograph.)

Topoclimatic Studies of a Small Plateau Ice Cap, Northern Ellesmere Island, N.W.T., Canada

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It has often been noted that negative feedbacks between snow and ice-covered surfaces and the atmosphere must have played an important part in maintaining (and perhaps even enlarging) ice or snow-covered areas during the initial stages of glacierization (e.g. Kellogg, 1975). Indeed, this feedback process is an implicit part of the "theory of instantaneous glacierization" first outlined by Brooks (1926) and later elaborated by Flint (1943) and Ives, et al. (1975). In spite of this, the actual effect of snow or ice-cover on local climate has not been adequately studied. It is clear that an ice/snow cover will increase albedo, reduce net radiation and lower local temperatures (thereby reinforcing its own prospects of survival) but these effects and their spatial dimensions have rarely been quantified (cf. Braithwaite, 1977).

To assess the magnitude of this "ice cap effect," a study was initiated on a small summit ice cap on the northeastern edge of the Hazen Plateau, Ellesmere Island, N.W.T., Canada in the summer of 1982. The ice cap, situated at 81°57'N, 64°10'W, is thin (estimated <50 m thick), completely unshaded by adjacent terrain, extremely flat, and surrounded by unglacierized plateau summits at similar elevations. It thus presents an ideal situation to study the effect of the ice cap itself on the local climate. To this end, three micrometeorological stations ('Zebra', 'Yankee' and 'X-Ray': see Figure 1) were maintained along a transect from the center of the ice cap to an unglacierized summit ∿3 km away. The sites differed in elevation by <10 m; the major difference between the sites was thus the underlying surface and proximity to the ice cap. Winter balance on the ice cap is shown in Figure 1. Specific net winter balance was 14.9 cm (w.e.). An original stake network established by Hattersley-Smith and Serson (1973) in 1972 was expanded to 28 stakes. The following parameters were measured (hourly) through the ablation season, from early June to late July: (at Yankee) incoming short-wave and incoming long-wave radiation; (at all sites) net radiation reflected short-wave radiation (albedo), air temperature at 15, 150 and 300 cm, relative humidity at 15 and 150 cm. Mean temperatures and melting degree days at the three sites are shown in Table 1. A clear gradient exists from the ice cap center to the unglacierized station X-Ray, only 3 km away, where melting degree day totals were 50% higher than on the ice cap itself. Intermediate values were recorded just 700 m beyond the ice edge at station Yankee. Figure 2 shows net radiation at the three sites; a significant reduction of available energy at Zebra is shown primarily due to a shorter period of snow cover and overall lower albedo at Yankee and X-Ray. Further studies over an expanded station network are planned for 1983.

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Table 1

Melting Degree Days Calculated From Daily Means*

	Zebra	Yankee	X-Ray
Temp 15 cm	--	115**	122
Temp 150 cm	55(100)	80(145)	88(160)
Temp 300 cm	53(100)	75(142)	81(153)

Temperature Means for Season*

	Zebra	Yankee	X-Ray
Temp 15 cm	0.7 ***	3.0	3.2
Temp 150 cm	0.9	1.7	2.1
Temp 300 cm	0.8	1.6	1.8

*Calculated Julian days 170-207, Days 175, 182 Eliminated.
**Julian day 203 also eliminated
***Calculated Julian days 178-207

Values in parentheses express melting degree days as a percentage of values at the Zebra ice station

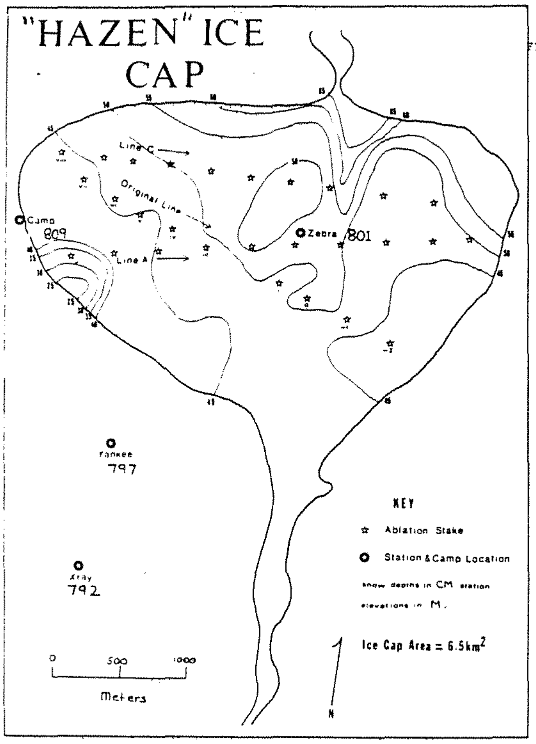

FIG. 1

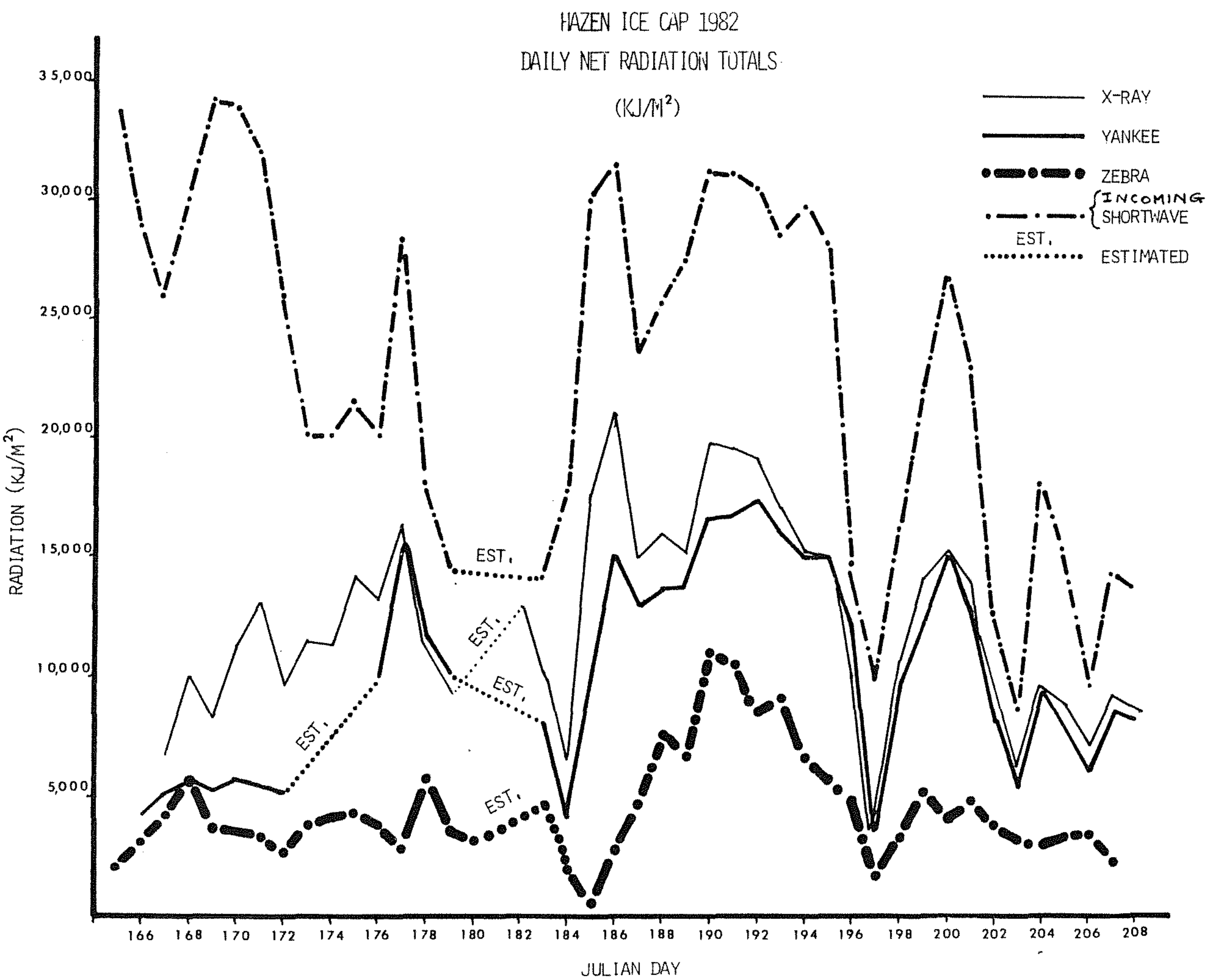

Figure 2

Late Foxe/Wisconsin Ice Masses of Outer Meta Incognita Peninsula, Southern Baffin Island, Eastern Canadian Arctic.

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INSTAAR and Department of Geological Sciences, University of Colorado

Regional reconstructions based on ice flow directional indicators, till provenance studies,(figure) relative weathering data, and radiocarbon dates indicate that three glacial ice masses influenced the glaciation of the Meta Incognita Peninsula. They include: 1) a local independent ice cap formed by the expansion of the Grinnell Glacier and Terra Nivea ice caps (figure) with an ice divide extending northwestward across the Everett Mountain plateau, 2) a major ice tongue (the Hall Advance) originating to the north in Foxe Basin and flowing southeastward down Frobisher Bay, and 3) glacial ice originating to the south (probably in Labrador), flowing in Hudson Strait and northeastward across the tip of the Peninsula (here referred to as the Noble Inlet Advance).

Local Ice Cap

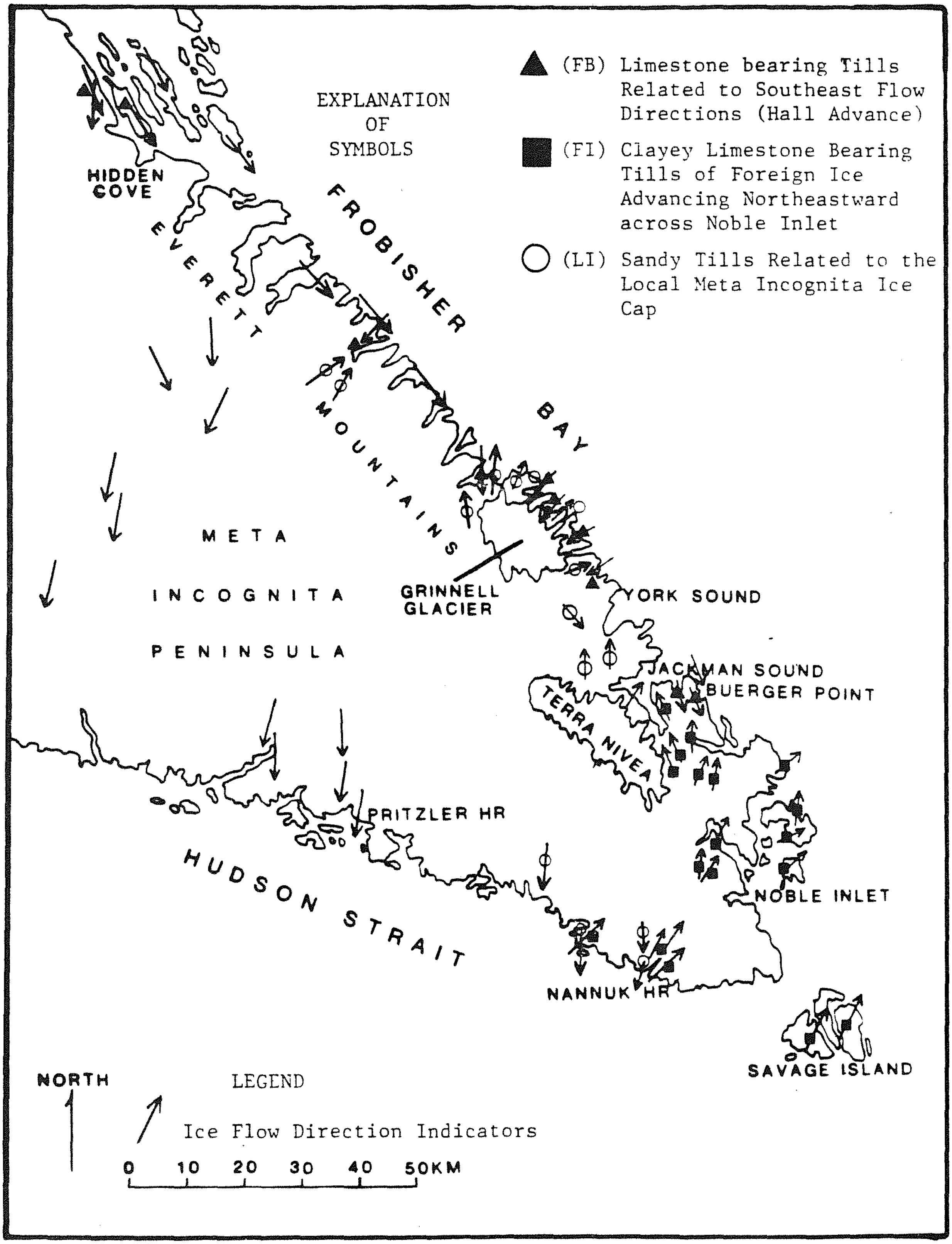
Tills from this ice cap are predominantly sandy tills containing crystalline clasts derived exclusively from local bedrock. Associated ice flow directional indicators suggest that an ice divide existed over the Everett Mountain plateau. Ice flowed northward into the Everett Mountain fiords (figure) where Late Foxe sandy terminal moraines are found. Similar till samples collected from west of Nannuk Harbour on Hudson Strait (figure) indicate that southward flow from this ice cap reached the northern shore of Hudson Strait.

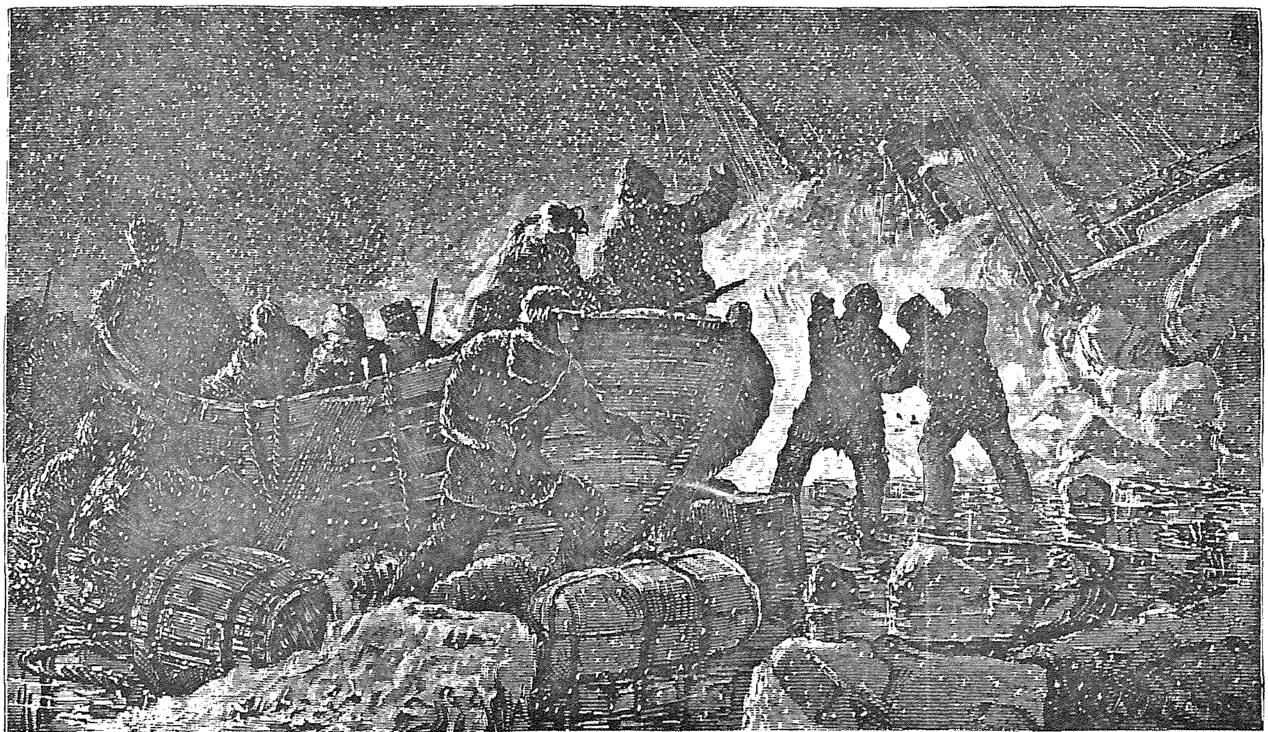
Frobisher Bay Ice

Limestone bearing tills associated with southeastward ice flow directions along the Everett Mountain coast (the Hall Advance) have been mapped as far down bay as Buerger Point (figure). Low elevation weathering breaks suggest that the Buerger Point area marks the terminus for the Hall Advance. Stratigraphic data show that a complex interaction occured when this ice merged with local ice in the Everett Mountain fiords and with Grinnell Glacier (figure). Striae in the Hidden Cove area (fig.) and the central peninsula show that Frobisher Bay ice overtopped the northwestern end of the Everett Mountains, merged with the western margin of the local ice cap and flowed southward into Hudson Strait (figure).

Hudson Strait Ice

Clayey limestone bearing tills associated with northeastward ice flow directions are found throughout the area of the outer tip of the peninsula (figure). The data suggest that this advance (referred to as the Noble Inlet advance) merged with the local ice between Jackman Sound and Nannuk Harbour (figure). It may have merged with the Hall Advance in the Buerger Point area since striations from both the Hall and Noble Inlet Advances are found here (figure). However to date no stratigraphic evidence or crossing striae have yet been found to indicate how these two ice masses interacted.


EXPLANATION
OF
SYMBOLS
(FB) Limestone bearing Tills Related to Southeast Flow Directions (Hall Advance)
(FI) Clayey Limestone Bearing Tills of Foreign Ice Advancing Northeastward across Noble Inlet
(LI) Sandy Tills Related to the Local Meta Incognita Ice Cap
HIDDEN COVE
EVERETT
MOUNTAINS
FROBISHER
BAY
META
INCOGNITA
PENINSULA
GRINNELL GLACIER
YORK SOUND
JACKMAN SOUND
BUERGER POINT
TERRA NIVEA
PRITZLER HR
HUDSON STRAIT
NOBLE INLET
NANNUK HR
SAVAGE ISLAND
NORTH
LEGEND
Ice Flow Direction Indicators
0 10 20 30 40 50KM



"THE SHIP BROKE AWAY IN THE DARKNESS, AND WE LOST SIGHT OF HER IN A MOMENT."

The Loss of the Polaris, Hall Basin, October 1872

From Arctic Experience, ed. E.V. Blake N.Y., 1874

Quaternary Acoustic and Biostratigraphy of the Inner Labrador Shelf

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High resolution HUNTEC Deep Tow and continuous seismic reflection profiles across the inner Labrador shelf show a discontinuous and complex sequence of Quaternary sediments deposited in isolated basins or troughs developed on the Precambrian crystalline bedrock. Regional correlation of these glacial-postglacial sediments is ambiguous because of the lack of continuity across the complex morphology of the inner shelf. Within the numerous basins and valleys of the inner shelf, the units commonly pinch out locally; and unless the cores are taken from exactly the same position as the acoustic profiles, precise correlation of the acoustic and biostratigraphic units is meaningless.

The interpretation of foraminifera from six piston cores taken across the inner shelf establishes three ecostratigraphic zones: A) a highly diverse arenaceous foraminifera assemblage encountered from the surface to about 1 m core depth; B) less diverse calcareous foraminifera dominated by <u>Elphidium excavatum</u> f. <u>clavata</u> and <u>Islandiella helenae</u> from approximately 1 m to about 5 m in the cores; and C) sediments almost completely devoid of fossils at the bottom of each core. According to a ^{14}C date of a mollusc shell, the top of Zone B is 5160 ± 330 y BP.

The faunal characteristics in Zone B are consistent along the 60 km traverse taken from a water depth of 95 m closer to shore to the 330 metre isobath offshore. Dominance of both late glacial species <u>E. excavatum</u> and postglacial species <u>I. helenae</u> suggest open inner shelf waters during the duration of Zone B. Paucity of faunas in Zone C and the presence of well-preserved pteropod shells at its most shoreward occurrence suggests relatively fast sedimentation rates and open water during summer along the inner shelf.

Although both Zones B and C are ecostratigraphically well defined, and the bottom of Zone B occurs at least 5 m below the sea floor, the B/C boundary cannot be readily recognized on the HUNTEC profiles. This would indicate that the B/C boundary does not represent enough of a physical change in sedimentary characteristics to produce an acoustic discontinuity such as that caused by the presence of grounded glacial ice. High sedimentation rates extrapolated from two shell ^{14}C dates in conjunction with ecostratigraphic evidence suggest that only postglacial sediments were sampled.

A Comparison of Evidence for Holocene Climatic Change in Baffin Island and the Surrounding Region

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Diagrams are presented which display a variety of evidence for climatic (or environmental) change during the Holocene in the east-central Canadian Arctic and Greenland. The kinds of evidence include: (1) pollen assemblages, interpreted (by others) either subjectively or by means of transfer functions, (2) rates of early Holocene retreat of ice sheet margins, (3) marine mollusc assemblages, (4) wood north of present treeline, (5) lichenometric dates on moraines, (6) proglacial sediment stratigraphy, (7) various kinds of deposits which suggest climatic change, (8) tree-ring width, (9) percent refrozen meltwater in ice cores, and (10) annual maxima of oxygen isotope ratios in ice cores. Most of the records considered are probably (though not necessarily) indicative of summer temperatures.

Three nested time intervals are considered: (1) the last 12,000 radiocarbon years, (2) 4000 B.C. to present, and (3) 600 A.D. to present. For the last two periods, radiocarbon dates are converted to calendar years (B.C. or A.D.) by means of dendrochronologic calibrations, for comparability with ice-core records. For the earlier period, "B.P." is to be understood as conventional radiocarbon years before 1950.

Many of the records disagree in detail, perhaps due to misinterpretation, dating uncertainty, or differing responses to climatic change, as well as the possibility of local anomalies. Therefore, it does not seem possible at present to describe with much confidence the history of climatic change in the region, and the diagrams are presented mainly for the sake of comparison and comment by the viewers. However, a summary of some of the main features of the records follows.

The early- to mid-Holocene is especially difficult to discuss on the basis of existing evidence. There is some suggestion that the period of ice margin readvance sometime between 8000 and 9000 B.P. was terminated synchronously with the seasonal opening of Davis Strait, the influx of subarctic species of molluscs in Baffin Bay, and the start of a long period of relatively warm-climate pollen assemblages in southwestern Greenland. Subsequently, a climatic optimum seems to have prevailed in the Baffin Bay region over a long interval, roughly 6500-3500 B.P., although some evidence from Baffin Island indicates that it was interrupted by a cold episode around 5000 B.P.

In the period 4000 B.C. to present, pollen transfer function reconstructions of summer temperatures in Keewatin and Baffin Island indicate generally warm conditions up to the first millenium B.C., and generally colder thereafter, although they differ greatly in detail. They do agree on a relatively cold interval within the earlier period, from about 2100 B.C. to 1700 B.C., and this is supported by a cluster of lichenometric dates on Baffin Island moraines. However, a far-northward extension of treeline in Keewatin is also dated within the period 2100-1700 B.C. After 1000 B.C., dates on treeline north of present treeline in Keewatin compare well with highs in the transfer function summer temperature reconstruction for the same vicinity, at about 900 B.C., 500-300 B.C., 400-600 A.D., and 1000-1200 A.D. On Baffin Island, two episodes of glacier expansion suggested by lichen dates on moraines compare very well with lows in a Greenland ice core meltwater record at around 200 B.C. and 400-500 A.D. Note that the latter cold episode contrasts with the warm episode in Keewatin at that time.

Various kinds of evidence for climatic change in the eastern Canadian Arctic during the last 1400 years are reasonably consistent, but those from Greenland ice cores disagree. The combined evidence from the eastern Canadian Arctic suggests that after a relatively warm 7th century A.D., the climate deteriorated into the 10th century. Warmer conditions then prevailed in the 11th and 12th centuries, followed by cooling to the 14th century. The 15th and early 16th centuries were warm, at times at least as warm as at present. The Devon Island ice core meltwater record indicates a sharp cooling in the late 16th century. This record, the northern Quebec tree-ring record, and the Baffin Island lichenometric dates on moraines all show remarkable agreement from 1650 to the present. These indicate cold periods in the late 17th century and early 19th century, with warming during the 18th century and late 19th to 20th century (the latter interrupted by cooling around 1900).

The 15th century warm period in this region is especially interesting, for it contrasts with evidence (tree ring and glacial) for a cold episode in western North America at that time.

The diagrams presented at this poster session are to be published in Williams and Bradley (1983).

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The Rescue of Greely & party,Pim Island,1884.

Raised beaches, "David's Bay,"
Archer Fiord, N.E. Ellesmere Island,
N.W.T. Canada, June 15 , 1978.
Photo by R. S. Bradley